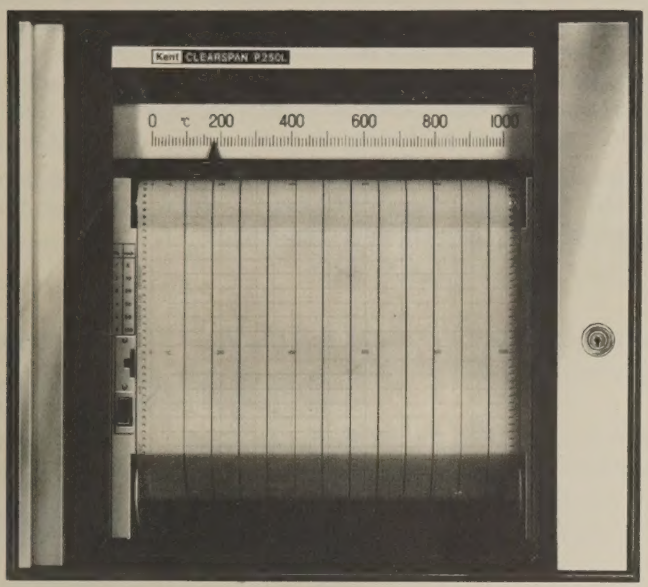
Foster Cambridge

CLEARSPAN P250L RECORDER

OPERATING INSTRUCTIONS



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This instrument is operated from a mains voltage supply and may be used in applications where high voltages are present on the signal leads. Observe the safety measures on page 4 before installing or carrying out adjustments. The components and circuits in which mains voltages are present when the instrument is operating are listed on page 10.

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INTRODUCTION

The P250L series of recorders is designed to measure, record and control signals from thermocouples, resistance thermometers or any transducer generating a current or millivolt signal. The measured values are recorded on a strip paper chart driven at a constant speed by a synchronous electric motor or by a stepper motor operated from a solid state electronic circuit. One of five different control units can be fitted to provide on/off or time modulated proportional control, or output signals to operate motorised valves or thyristor drive circuits. Three of the control units are for the simpler applications and the other two for more complex control requirements. Other optional features include chart illumination, two range switching, an event marker and an averaging pre-amplifier.

Automatic cold junction compensation is fitted on all thermoelectric instruments having a span of 6mV or more – e.g. 0/150°C BS 4937 Type K. Upscale or downscale open-circuit sensor protection can be provided on thermoelectric and millivolt instruments.

Specification

Number of signal channels on multipoint	2, 3, 4, 6 or 12
Multipoint sampling time	6 seconds standard on 50 or 60Hz supplies; 3 seconds sampling to special order, on 50Hz supplies only
Multipoint record colours	2 point: red, black 3 point: red, black, green 4 point: red, black, green, violet 6 point: red, black, green, violet, orange, blue 12 point: as 6 point but points 7 to 12 have circles instead of dots
Chart	Writing width 250mm; length 16 metres
Chart speeds:	
Single speed drive	5, 10, 20, 30, 60, 600, 1,200 or 3,600mm/hour
2-speed drive	5, 10, 20, 30, 60, 120, 600, 1,200 or 3,600mm/hour (not all combinations are available)
Multispeed Drive	5, 10, 20, 30, 60, 120mm/hour with standard motor 300, 600, 1,200, 1,800, 3,600mm/hour with high power motor and gearbox
Electronic drive	5, 10, 20, 30, 60, 120mm/hour
Minimum span	1mV 12.5°C on BS1904 thermometers, 38.5 ohms FI
Maximum span without potential divider	200mV
Zero suppression	Not to exceed 10x span
Intrinsic error	±0.25% span; BS Class 0.25 (at 20°C ambient temp.) ±0.5% span when isolator fitted ±0.5% fiducial value when zero suppressed
Dead Band	±0.1% span – maximum
Total response time	1 second maximum to within 1% of steady state indication
Operating temperature limits	–10°C to 55°C
Operating humidity limits	0 to 80% R.H.
Zero error due to ambient temperature variation	0 to 40°C: ±0.02% span/°C maximum –10 to 0°C: ±0.05% span/°C maximum 40 to 55°C: ±0.027% span/°C maximum
Span error due to ambient temperature variation	±0.01% span/°C typical
Warm up time	10 minutes
Power supply voltage and frequency	110V, 210V and 230V nominal, 50Hz; 60Hz to special order
Power requirements	60W maximum (with control and other options)
Error due to power supply voltage variation	±0.1% span maximum for +10% to –15% variation
Fuse	500mA anti-surge, $\frac{3}{16}$in diameter x $\frac{5}{8}$in.
Spurious signal rejection	
Common mode	±0.5% span error maximum for 10V r.m.s. 50Hz
Series mode	±0.5% span error maximum for r.m.s. 50Hz signal equivalent to 25% span

Maximum source resistance	5,000 ohms
Standing current through source	0.5 nA maximum (without broken sensor protection fitted)
Automatic cold junction compensation	On all spans 150°C and greater. Maximum error in indication resulting from A.C.J.C. circuitry 0.04°C per degree C change in ambient temperature
Broken sensor protection	Normally upscale on thermoelectric instruments, and downscale on mV instruments unless otherwise specified, but only fitted on customer request.
Insulation resistance	$>$20 MΩ with 500V DC between power supply terminals and earth
Time delays of averaging pre-amplifier	3, 10 or 30 seconds nominal — single point instruments only (Only fitted on customer request)
Conditioner	
Input signals from transmitters	0–10mA into 550 ohms maximum or 4–20mA into 350 ohms maximum
Square Root Extractor	
Input signals from transmitters	0–10mA into 500 ohms maximum or 4–20mA into 320 ohms maximum or 0–5V, maximum source current 5 μA
Electrical alarm and control relays	Double pole changeover, 240V, 5A, 50 Hz, non-inductive loads.
Time Proportioning Control	
Period	20 seconds approx.
Proportional Band	0–5% span nominal, adjustable
Integral Action time	5 minutes nominal
Current Output for Thyristor Drive	
Output	0–5mA into 2 kΩ maximum or 0–10mA into 1 kΩ maximum. (Short circuit will not damage the instrument but the output circuit must not be earthed)
Proportional band	2% to 10% span nominal, adjustable
Integral Action Time	5 minutes nominal
Motorised Valve Control	
Proportional band	2% to 10% span nominal adjustable
Integral action time	5 minutes nominal
Valve Motor specification	
Slidewire swept resistance	140 ohms minimum
Slidewire total resistance	155 ohms maximum
End of travel limit switches must be fitted	
Motor supply (not provided in P250L)	60V r.m.s., maximum, 1A maximum
Balance relay not required	
Retransmission Signal	
Intrinsic error	$\pm$0.5% span maximum (referred to incoming measured value signal)
Output current	0–10mA into 1,000 ohms maximum or 4–20mA into 500 ohms maximum
Isolation	Isolated from chassis but not from input sensor
Overall dimensions	435mm wide, 386mm high, 305mm deep
Panel cut-out	406 $\pm$ 1mm wide, 360 $\pm$ 1mm high
Maximum Panel thickness	35mm
Weight	26 kg

Safety Measures

Before making any connections to the instrument or carrying out any maintenance, switch off the mains supplies to all circuits to be connected – including control circuits and any high voltage input signals or common mode supplies to the signal leads. Circuits and components where mains voltages may be present, are detailed separately on page 10.

Note that to ensure the optimum instrument performance the pre-amplifier case is electrically connected to the signal leads and the setting up procedure should not be carried out with any common mode voltage greater than 40V R.M.S. on the signal leads.

In some applications an isolator is fitted after the pre-amplifier so that signals with common mode voltages up to 500V 50Hz may be monitored. Users should be particularly careful to switch off such voltages before carrying out the setting up procedures or changing range. In such applications the user should fit a fuse in each signal lead, preferably rated at 100 or 200mA. These fuses and the external signal circuits must be adequately isolated for the full applied voltage and suitably protected. A reliable low resistance overall instrument earth connection is essential.

When high voltage input signals greater than 40V R.M.S. are present, it is quite safe to open the door to the instrument and the chart unit, but care should be taken when opening the main frame as these voltages are present on the pre-amplifier case, and the selector switches in multipoint recorders.
If a fault develops such that the signal leads come into contact with a high voltage, all of the instrument circuits, including the slidewire and set point pontentiometer, will be raised to that voltage.

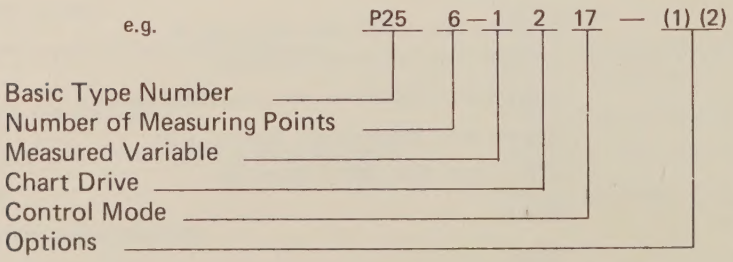
This instruction manual covers all the standard variants of the P250L recorder, but does not cover modifications to the instrument to meet particular user requirements which may have resulted in the presence of mains voltages in locations not detailed in the manual. If such modifications have been made at the factory during manufacture reasonable user protection will have been provided, but customers are urged not to operate the instrument with protective covers removed and not to carry out maintenance procedures without first making the recorder "Safe".

Service Manual

A Service Manual, part number P250/50/3549 is available. This contains full fault finding charts, faulty sub unit replacement and alignment procedures and wiring diagrams etc. Users wishing to carry out their own maintenance and servicing are recommended to purchase this item.

Identification

The instrument code number shown on the serial number plate in the bottom of the case is in three sections and is derived as follows (see chart opposite):



Basic Type Number	No. of Measuring Points	Measured Variable	Chart Drive	Control Mode and Set Points	No. 1	No. 2	Options
P25 Potentiometric Recorder with 250mm. chart width	**Single Pt.** 1 One pen **Multipoint** 2 Two pt. 3 Three pt. 4 Four pt. 6 Six pt. 7 Twelve pt.	**Single Range** 1 Thermocouple 2 Resistance Thermometer 3 Linear Voltage (1 to 200mV span) 4 Potential Divider (Above 200mV span) 5 Direct Current (less than 10mA span) 6 Direct Current — Transmitter Input (10mA span and above) 9 Others **Two Range** 8 Multipoint Automatic (for 2, 3 & 6 pts.)	**Speeds up to 120mm/h.** 1 Single speed 2 Two speed 3 Multispeed **Speeds of 300mm/h. and above** 4 Single speed 5 Two speed (one of 120mm/h or less) 6 Multispeed **Magslip** 7 Multispeed **Variable Speed** 8 Dial Selection of 6 pre-set speeds up to 120mm/h.	**Without Control Unit**			(1) Chart Illumination
				17 Recorder only	—	—	
				Basic Control Unit 1			(2) 60Hz supply
				28 Recorder + current output	—	—	
				16 Recorder + two current outputs	—	—	(3) 3 sec. dotting
				00 Two step (on/off) control	A	—	
				01 Two step (on/off) control	B	—	(4) Autoswitch for chart motor
				29 Two step + current output	B	—	
				30 Two step + current output	A	—	
				05 Three step control	B	B	
				06 Three step control	A	A	(5) Single point trace on Multipoint
				09 High-low control	A	B	
				18 Time proportioning (P + I)	B	—	
				19 Time proportioning (P + I)	A	—	
				31 Time prop. + current output	B(P+I)	—	(6) Event Marker
				32 Time prop. + current output	A(P+I)	—	
				20 Time prop. + two step	B(P+I)	B	(9) Chart Tear Off
				21 Time prop. + two step	B(P+I)	A	
				22 Time prop. + two step	A(P+I)	B	(10) Single point hold on Multipoint
				23 Time prop. + two step	A(P+I)	A	
				Motorised Valve/Thyristor Control Unit 2			(16) Averaging Pre-amplifier
				33 Prop. for thyristor	C	—	
				53 Prop. thy. + current output	C	—	(17) Isolator
				34 Prop. thy. + two step	C	B	
				35 Prop. thy. + two step	C	A	(18) Slow printing
				38 P + I for thy.	C	—	
				54 P + I thy. + current output	C	—	(19) Printing by External Contact.
				39 P + I thy. + two step	C	B	
				40 P + I thy. + two step	C	A	(20) Square Root Extractor
				43 Prop. for mot. valve	C	—	
				55 Prop. mot. valve + current output	C	—	(21) Conditioner
				45 Prop. mot. valve + two step	C	B	
				46 Prop. mot. valve + two step	C	A	(23) Chart Tear Off with scale on chart platen
				44 P + I for mot. valve	C	—	
				56 P + I mot. valve + current output	C	—	(24) Bench Stand
				49 P + I mot. valve + two step	C	B	
				50 P + I mot. valve + two step	C	A	(25) Wall Mounting Bracket
				Individual Control Unit 3			
				61 Two step — one set point			
				62 Two step — two set points			
				63 Two step — three set points			
				64 Two step — four set points			
				65 Two step — five set points			
				66 Two step — six set points			
				Single Point Universal Control Unit 4			
				80 Three to six control modes			
				Multipoint Universal Control Unit 5			
				81 Two step — one set point			
				82 Two step — two set points			
				83 Two step — three set points			
				84 Two step — four set points			
				85 Two step — five set points			
				86 Two step — six set points			

A:— Relay energised above set point.
B:— Relay energised below set point.
C:— Set point on P or P + I control.

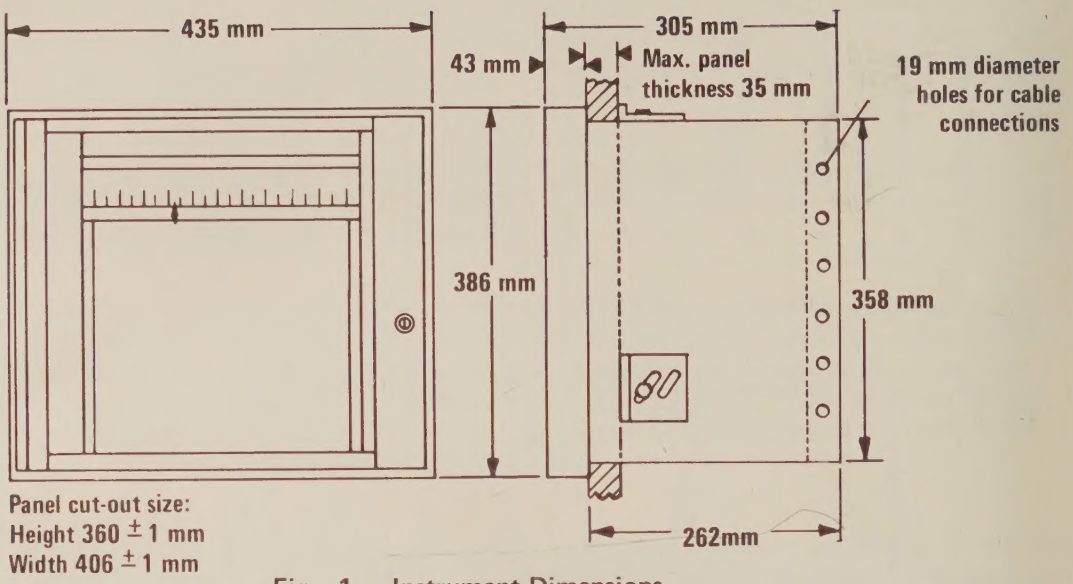


Fig. 1 Instrument Dimensions

Mounting

Mount the recorder so that it is vertical. Select a site away from strong electric fields – e.g. arc furnaces, transformers or actuators. Do not install near very hot apparatus – e.g. ovens, steam pipes or flues, or where the instrument will be subject to excessive vibration.

The recorder is designed for panel mounting. Insert the instrument in the panel cut-out. Bolt the clamps supplied onto the top and sides of the case, so that they bear against the back of the panel, and tighten the bolts.

Alternatively, a wall mounting bracket is available. Make sure that the bracket is securely fastened to a wall or support. When fastening to a wall, drill 14.5mm ($\frac{9}{16}$in) dia. holes in the wall and use the expanding 'Rawlbolts' supplied.

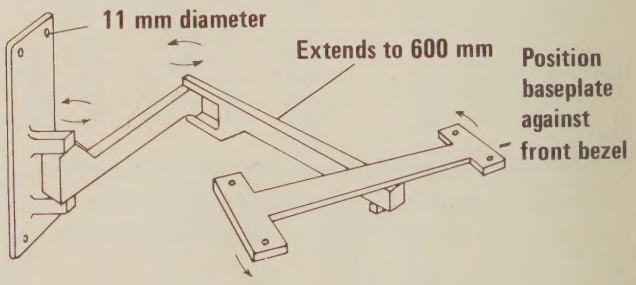


Fig. 2 Wall Mounting Bracket

Electrical Connections

Refer to section **Safety Measures,** page 4 before making any connections

All connections are made to the terminal blocks under the cover at the rear of the case – see Fig. 9. Remove the cover by loosening the four corner screws. Be sure to adjust the voltage selector wire to the correct supply voltage – see Fig. 3 – before switching on.

On thermoelectric spans when automatic cold junction compensation is fitted the correct compensating lead, as detailed in Table 1 page 12, must be used to connect the thermocouple to the instrument. For spans less than 150°C a reference junction oven is usually supplied and compensating cable must then be used from the thermocouple to the junctions in the oven with copper cable from the oven to the recorder.

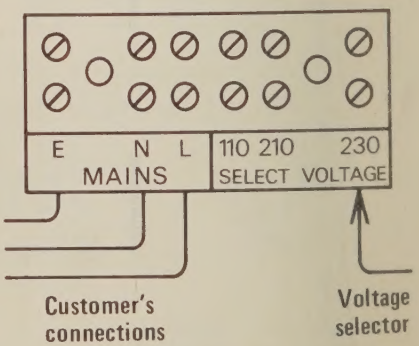


Fig. 3 Mains Connections and Voltage Selector

On all thermoelectric instruments where the temperature of the head of the thermocouple is likely to exceed 55°C use a thermocouple extension cable between the head of the thermocouple and the compensating leads (or instead of the compensating leads).

On 2-lead resistance thermometer instruments, the lead resistance should not exceed 5 ohms, Table 2, page 13, details the maximum permissible length of various sizes of double run wire.

To reduce the effect of any electrical interference which may occur, either of the following procedures may be adopted:

(a) Twist the signal leads together and route them separately from mains-carrying cables, ideally in earthed metal conduit
or

b) Use screened cable for the signal leads and route them separately from mains-carrying cables, ideally in earthed metal conduit. Connect the screen to the earth terminal on the recorder.

OPERATION

Access to Recorder

To open the door, press the central plunger of the lock and pull the door forward from the right. The inner chassis consists of two parts – the main frame and the chart unit. These are hinged on the right hand side and may be swung out together or separately by releasing the appropriate catch on the left hand side of the chassis. Make sure that the door has been fully swung back, then place the fingers over the catch and pull forward.

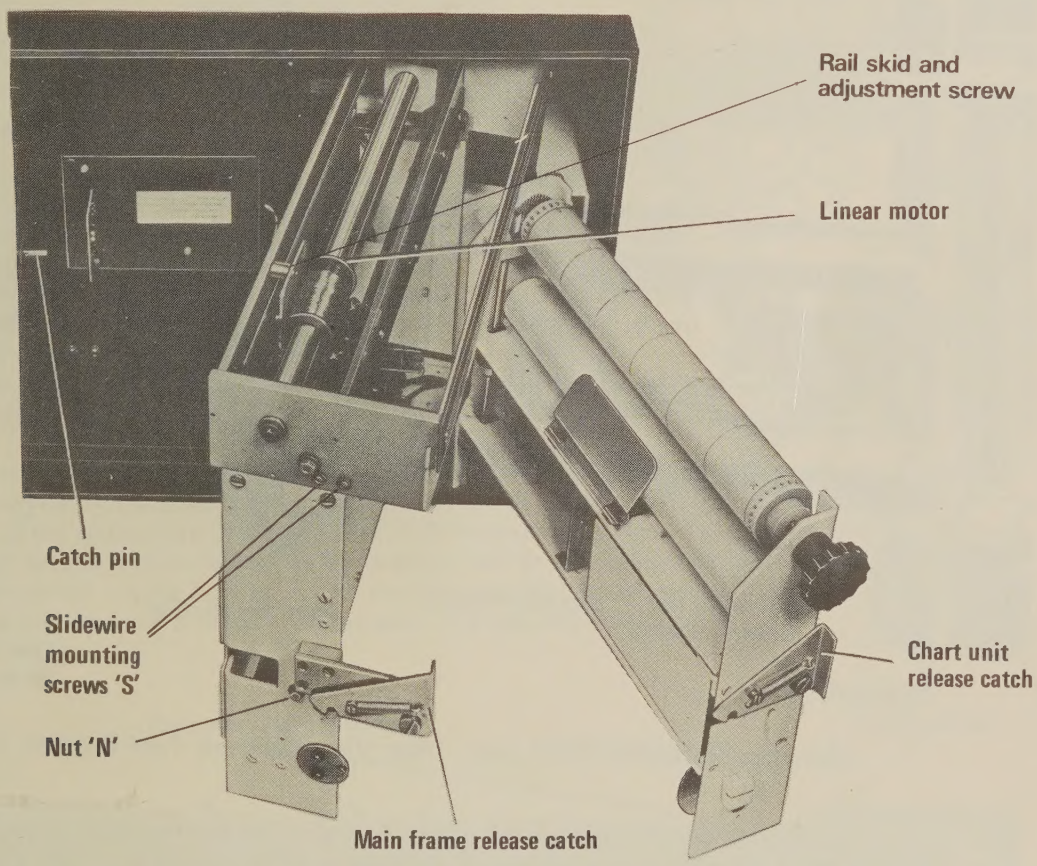


Fig. 4 Recorder Open for Access to Main Frame and Chart Unit

The mains on/off switch is mounted next to the main fuse in the central section of the bulkhead behind the main frame. A chart drive on/off switch is fitted in the front of the chart unit. On all recorders other than those with electronic chart drive there is a neon indicator immediately above the chart drive switch. Instruments with electronic chart drive have a numbered thumb wheel switch for chart speed adjustment, in place of the neon.

Multipoint recorders may be fitted with a 'point hold' switch. This is situated near the mains on/off switch (see Fig. 8). By operating this switch the dotting mechanism and signal selector switch may be stopped on any measuring point.

Shipping Ties

The linear motor carriage is tied in place during transit and the ties must be removed before the recorder can operate. Remove also the ties and packing around the chart take up roller. The carriage should be tied in place if the recorder is to be returned to the manufacturer or transported a significant distance.

Fitting a new Chart

Switch off the chart drive and swing the chart unit forward. Referring to the rear of the chart unit, remove the used chart by pressing it against the right hand flange of the take-up roller so that the chart drops clear of the left hand flange and can be lifted out. Remove the right hand flange unit from the chart roll by pulling it out with an unscrewing action. Take the cardboard tube on which the chart was originally wound from behind the chart tensioner at the top of the chart unit and fit it on to the right hand flange unit making sure that the notch in the tube fits over the small projection on the shaft. Replace the right hand flange unit with the cardboard tube attached, in the chart unit, fitting the other end of the tube on the left hand flange, again ensuring that the notch in the tube fits over the projection on the flange. The cardboard tube thus becomes the new take-up roller.

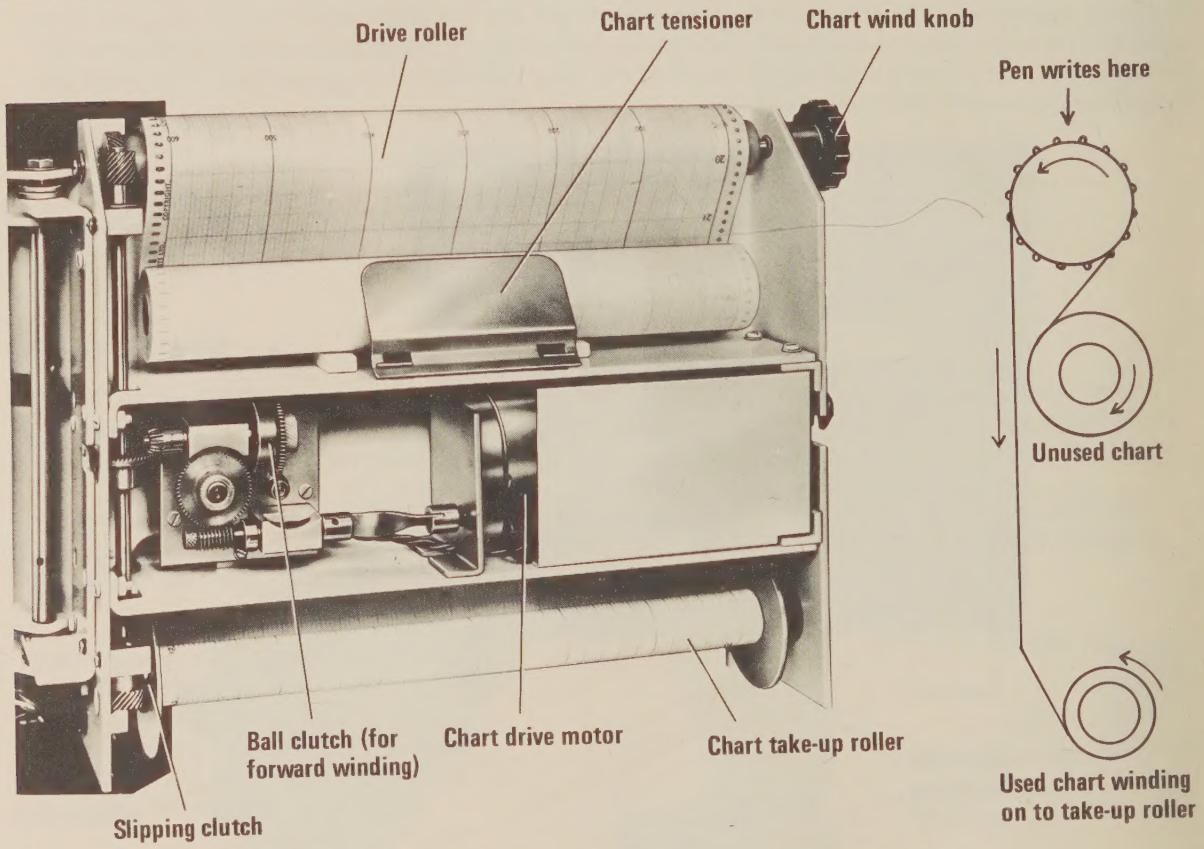


Fig. 5 Multispeed Chart Unit – Rear View and Paper Feed Diagram

Place the new chart roll behind the chart tensioner so that as the paper is brought forward over the drive roller sprockets, the printed side is uppermost. Slightly unroll the chart so that it extends about 150mm. below the bottom of the chart unit. Use a small piece of adhesive tape to attach the pointed end of the chart to the roller so that the chart is centralised on the roller. Wind up the slack chart on to the take-up roller by rotating the flanged end, making sure that the chart runs straight and central. Swing the chart unit back into the recorder. Rotate the black knob at the top left hand side of the chart unit (viewed from the front) until the pen is lined up with the correct time marking on the side of the chart.

Early models of this instrument have slotted take-up rollers. In this case, when removing the used chart, the left hand flanged end of the take-up roller will drop clear of the drive bush as the right hand flange is pressed to the right and the whole roller assembly can be lifted out. Remove the right hand flange unit from the take-up roller tube by pulling it out with an unscrewing action. Slide off the used chart. Replace the right hand flange unit on the take-up roller tube. Place the new chart roll in the chart unit as described in the previous paragraph. Insert the pointed end of the new chart in the slot in the take-up roller and take up one turn of the slack paper before replacing the take-up roller assembly in the recorder. Wind up the slack chart on the take-up roller and then swing the chart unit back into the recorder. Wind on the chart until the pen is lined up with the correct time marking.

Fitting the Ink Reservoir and Pen Nib (Single Point Recorders)

Swing the chart unit out of the recorder. The ink is supplied in a capsule with a ball bearing seal which can be broken by pushing the ball into the capsule. **Do not use the ink feed tube for this purpose.** Also, pierce a small hole in the front of and close to the top of the capsule; this prevents flooding of the pen when the chart is stationary. Fit the neck of the capsule over the flange on the underside of the pen, and spring the clip into position to hold the capsule in place.

Take a new fibre tip nib from the pack of four supplied and fit it over the writing end of the ink feed tube. Prime the pen by covering the pierced hole in the ink capsule, use the thumb and forefinger to close the air intake at the bottom of the priming bulb, and squeeze gently until ink comes through the nib.

Fitting the Ink Reservoir (Multipoint Recorders)

Standard instruments have open ink wells with pen pads which must be re-inked when necessary but some multipoint recorders may be supplied with sealed plastic ink wells which can be replaced when the trace becomes too faint. Instruments are normally despatched to the user with the inked ink well packed separately.

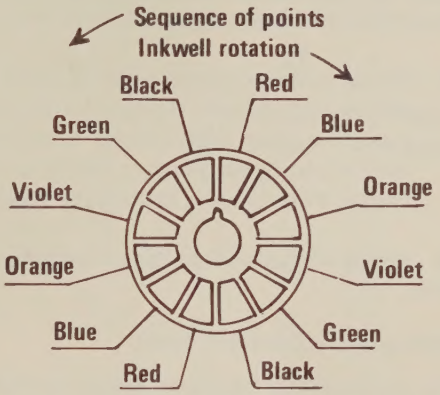


Fig. 6 6 and 12 Point Inkwell Colours (Top View)

To fit the inkwell, first remove the thin plastic seal covering the underside of the well if it is the sealed type. Swing out the main frame and chart unit and switch off the recorder. Unscrew the milled nut on top of the used ink well, see Fig. 7, and lift the well off. Place the new ink well in its place, making sure that the small projection on the boss fits into the groove on the underside of the inkwell, see Fig. 6. Replace the milled nut and screw it down firmly. Switch the recorder on.

When re-inking the pen-pads, swing out the main frame and chart unit and switch off the recorder to avoid getting ink in the mechanism. Two or three drops of each coloured ink should be dropped carefully on to the appropriate ink pad, rotating the turret manually in a clockwise direction, viewed from above. If set point potentiometers are fitted, it will be necessary to move the pen assembly to a central position for inking, see Fig. 7. The recorder pen will automatically re-synchronise with the signal selector switch when it is switched on again. **Do not over ink.**

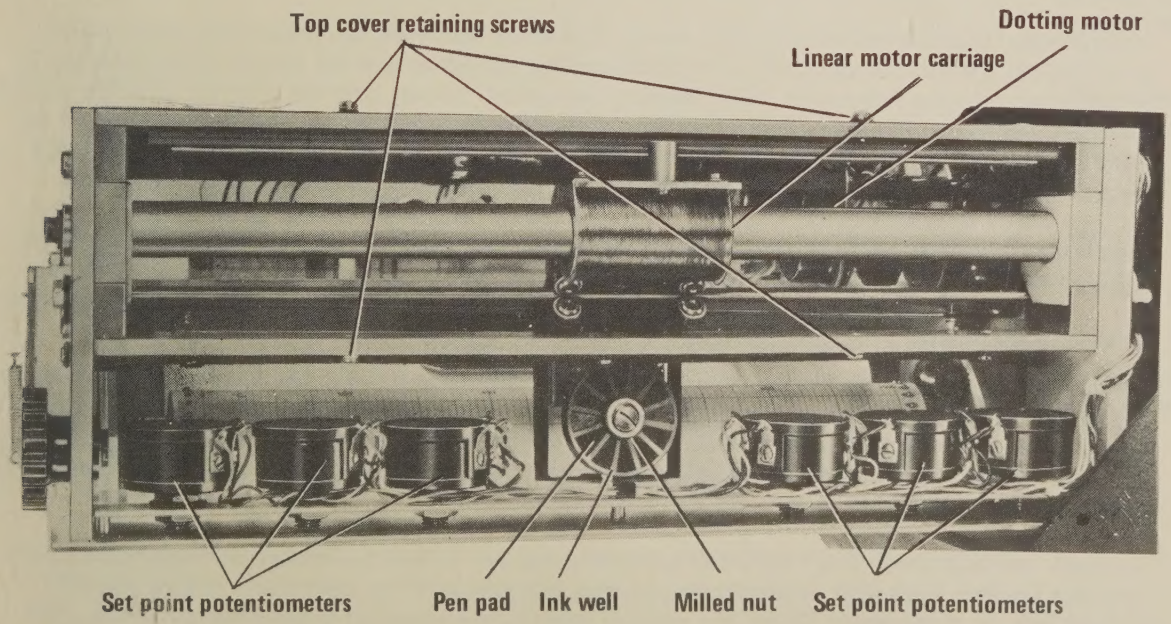


Fig. 7 Linear Motor and Set Point Potentiometers with Multipoint Pen in Inking Position

Mains Voltages

Listed below are the components and circuits in which mains voltages are present when the instrument is operating. Protection is provided from accidental contact but the mains supply should be switched off before attempting maintenance on these items.

(1) The connections to the primary winding of the mains transformer including the mains switch, and fuse. Voltages up to 250V r.m.s. may be present.

(2) The chart illumination circuitry including the starter and choke. On early instruments prior to serial number L459738 this operates from 240V r.m.s.; on subsequent models a 110V system is used.

(3) The chart drive motor and associated switch and neon are supplied from 110V r.m.s. unless an electronic chart drive is fitted. This operates from 24V D.C.

(4) On early instruments prior to serial number L459738 the multipoint signal selector motor and the multipoint pen dotting motor are operated from 240V r.m.s. On present models a 24V system is used. Instruments fitted with 240V motors incorporate an isolating relay in the pen motor and signal selector switch synchronising circuitry. This relay is mounted on a printed circuit board in the rear of the main frame and mains voltages are present at the relay terminals.

(5) Mains voltages from the customers control circuitry may be present inside the control relays.

Setting Up – Zero and Span

The pre-amplifier unit is mounted on the lower left-hand corner of the bulkhead and is accessible on swinging out the main frame, see Figs. 4 & 8. The ranging components are fitted on a range card which plugs into the pre-amplifier. Zero and span controls for use with millivolt and thermoelectric inputs are fitted on the pre-amplifier circuit board, and adjustable with a screwdriver through holes in the cover of the pre-amplifier. For resistance thermometer inputs zero and span adjustments should be made on the R/T bridge printed circuit board mounted in the terminal compartment of the recorder, see Fig. 9. The zero and span controls are set before despatch.

When checking the calibration of a multipoint instrument (other than one for use with two-lead resistance thermometers, or having automatic range changing), only one test signal need be used. The signal should be connected to the single point terminals, having first disconnected the existing leads from the terminals on the label side of the terminal block. By this method, the signal selector switches are by-passed, and the recorder monitors the test signal only, whilst continuing to dot the full sequence of colours.

Alternatively, stop the recorder on each signal channel by operating the point hold switch or by switching off the mains supply and then disconnecting the signal selector switch motor, see Fig. 8, by means of the plug and socket in the leads to the motor. Do not stop the recorder with the pen on the chart. Switch on the mains supply and check that the recorder has not stopped with the servo amplifier muted, i.e., that the servo system rebalances when the linear motor carriage is displaced manually. Muting occurs whilst the signal selector switch is changing measuring channels.

A convenient voltage source for use during calibration checks is the Portable Potentiometer Type PP322 manufactured by Kent Industrial Measurements Ltd.

Millivolt Instruments

Connect the signal leads to the input terminals (identified (+) and (–)). Use insulated copper wire of 2.5mm^2 cross sectional area. Use screened cable if interference is a problem, connecting the screen to the earth terminal on the case. Where optimum screening is required (e.g. on 1mV spans) take the screen to the same terminal as the mains earth. Switch on, and allow 10 minutes for the circuits to stabilise.

To check the calibration short the input terminals together or inject a voltage corresponding to the zero reading and check that the indicating pointer is in line with the zero mark. Adjust the zero control (Fig. 8) if necessary. Check the span by injecting a voltage corresponding to the full scale reading. If necessary, adjust the span control, then re-check the zero.

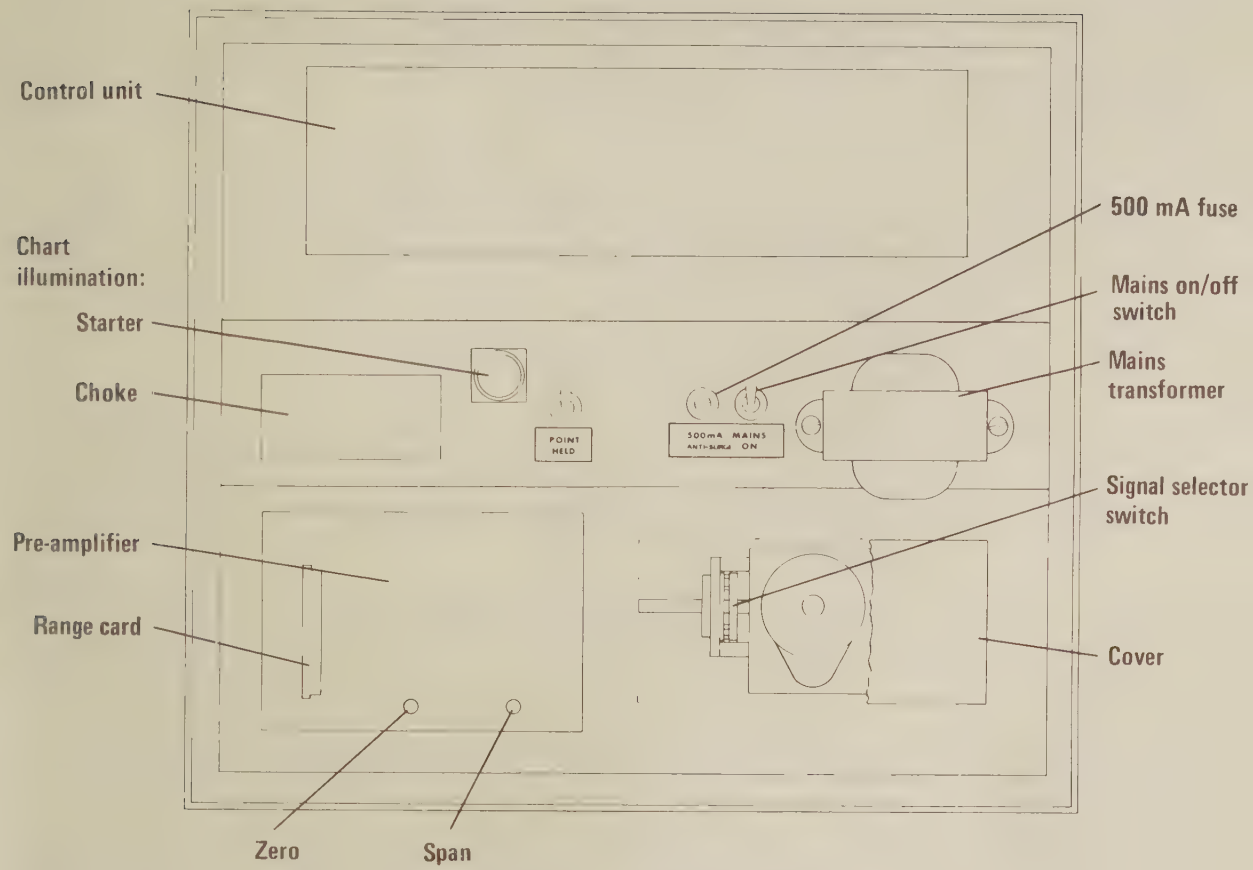


Fig. 8 Bulkhead Layout

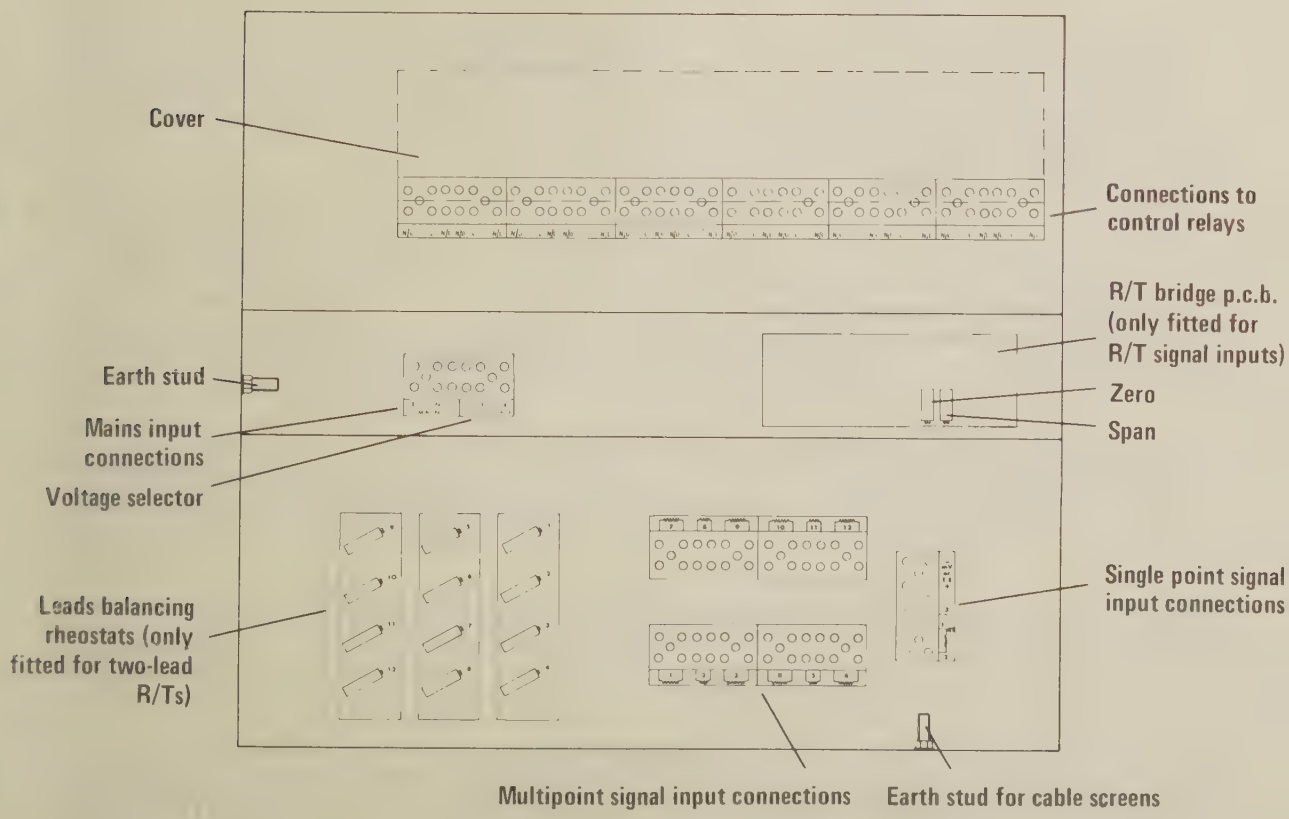


Fig. 9 Terminal Compartment Layout

Thermocouple Instruments
Connect the signal leads to the input terminals (identified (+) and (—)).

Compensating cable of the correct type must be used between the thermocouple and the recorder or reference junction oven, according to this table:—

Type of Thermocouple	Standard No.	Compensating Cable		Casing Colour
		+	—	
Copper-Con (T)	BS 4937 Pt. 5 (was BS 1828)	Copper (white)	Con (blue)	Red
Iron-Con (J)	BS 4937 Pt. 3 (was BS 1829)	Iron (yellow)	Con (blue)	Black
Ni/Cr-Ni/Al (K)	BS 4937 Pt. 4 (was BS 1827)	Copper (white)	Con (blue)	Red
Pt-Pt/Rh (S & R)	BS 4937 Pts. 1 & 2 (was BS 1826)	Copper (white)	Copper/Nickel(blue)	Green
Ni/Cr-Con (E)	BS 4937 Pt. 6 (NBS 561)	Chromel (brown)	Con (blue)	Brown

Table 1. Thermocouple Compensating Cables

Correct polarity must be observed. If interference is a problem, use screened cable, connecting the screen to the earth terminal on the case. Switch on and allow 10 minutes for the circuits to stabilise.

To check the zero setting only:—

Short circuit the input terminals of the recorder with a short length of copper wire. Measure the temperature at the input terminals and adjust the zero control on the pre-amplifier (see Fig. 8) until the recorder indicates this temperature.

To check the calibration:—

(1) Measure the ambient temperature at the rear terminals of the instrument, or the temperature of the reference junction when used.
(2) Obtain the equivalent voltage for this temperature from tables.
(3) Look up the voltage corresponding to scale minimum.
(4) Subtract the voltage in step (2) from that obtained in step (3). (This may be negative if scale minimum is less than (1)).
(5) Inject the resultant voltage at the controller signal terminals, using a Foster Cambridge Portable Potentiometer or similar instrument; the connecting leads should be copper wire. Adjust the zero control to bring the pointer to scale minimum.
(6) If necessary adjust the span control to set full scale indication in a similar manner to steps (1) to (5).
(7) If a span adjustment has been made, recheck the zero setting using steps (1) to (5).
(8) Connect the thermocouple wires to the rear terminals taking care to observe correct polarity.

Resistance Thermometer Instruments
Resistance thermometers have either two or three leads. Two-lead thermometers may be connected either way round to the terminals marked 1 and 2, but three-lead thermometers must be connected with all three leads wired to the appropriate terminals, as shown in the single point signal input connections, Fig. 9.

On multipoint instruments supplied specifically for 2-lead resistance thermometers, terminal '3' is not fitted and the markings '1' and '2' are omitted (see Fig. 9).

If electrical interference is a problem, use screened signal cable.

Resistance thermometer instruments have an additional printed circuit board, referred to as the R/T Bridge circuit, situated in the terminal compartment of the instrument in the position shown in Fig. 9. The resistance thermometer zero and span controls are on this board and should be adjusted as described on page 13. **Do not adjust the zero and span controls on the pre-amplifier.**

Instruments for use with Two-Lead Resistance Thermometers

The resistance of the leads is a very important factor in two-lead resistance thermometer systems, since it causes a zero shift. Up to 5 ohms lead resistance is permissible – equivalent to:–

93 m of double run	0.75 mm^2	cross sectional area copper wire
125 m of double run	1.0 mm^2	cross sectional area copper wire
180 m of double run	1.5 mm^2	cross sectional area copper wire
304 m of double run	2.5 mm^2	cross sectional area copper wire

Table 2. Maximum Permissible Two-Lead R/T Cable Lengths

A test coil (standard resistance) can be supplied with resistance thermometer recorders. To check the calibration on a single point recorder, connect the test coil in place of the thermometer at the sensor end of the thermometer cables, and adjust the zero control on the R/T bridge printed circuit board to bring the indicating pointer to the temperature marked on the test coil.

On a multipoint recorder for use with two-lead resistance thermometers, each thermometer is wired in series with a leads balance rheostat. These rheostats are mounted on circuit boards in the rear terminal compartment, numbered as shown in Fig. 9 to correspond with the appropriate measuring channel numbers. They must be adjusted as follows:–

Stop the recorder on channel 1.

Insert the test coil in place of the appropriate thermometer at the sensing end of the input cable and adjust the lead balancing rheostat for that input until the pointer indicates the temperature marked on the test coil. Repeat this process for the other channels.

If a test coil is not available use a resistance box instead, referring to the appropriate resistance thermometer tables. It will then be possible to check both zero and span settings. Adjust the full scale reading by means of the span control on the R/T bridge circuit board. **Do not** adjust the zero or span controls on the pre-amplifier.

Instruments for use with Three-Lead Resistance Thermometers

The resistance of the leads is not important in a three-lead system provided that the resistances of all three leads are approximately the same and each lead is less than 5 ohms.

To check the calibration of a single point instrument, connect the test coil in place of the thermometer at the sensor end of the thermometer cables, linking leads 1 and 3 together. If necessary adjust the zero control on the R/T bridge circuit board until the pointer indicates the temperature marked on the test coil.

To check the calibration of a multipoint instrument stop the recorder on measuring channel 1. Connect a test coil in place of the thermometer, connecting lead 3 with lead 1 to one terminal of the test coil. Adjust the zero control on the R/T bridge circuit board until the pointer indicates the temperature marked on the test coil. No checks are necessary on the other channels.

If a test coil is not available use a resistance box instead, referring to appropriate resistance thermometer tables. It will then be possible to check both zero and span settings. Adjust the full scale reading by means of the span control on the R/T bridge circuit board. **Do not** adjust the zero and span controls on the pre-amplifier.

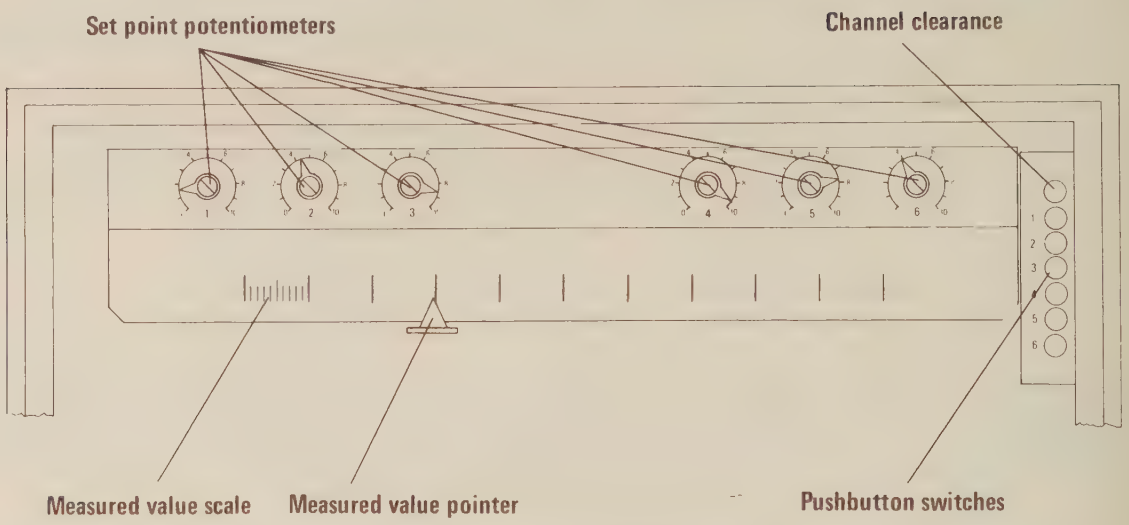


Fig. 10 Set Point Potentiometers

Up to six screwdriver adjusted potentiometers may be fitted above the measured value scale, each with its own circular scale giving a coarse indication of the control point setting. Numbered 1 to 6, each is associated with a pushbutton switch and for fine adjustment the measuring system may be switched to indicate the control point value by means of the appropriate pushbutton switch (see Fig. 10). The channel clearance button returns the measuring system to its primary function. Closing the door also operates this channel clearance mechanism so that there is no risk of the recorder being inadvertently left in the set point adjust condition.

Start-Up Check

Before putting the recorder into operation, make sure it is correctly installed and operational by checking that:—

1. Each measuring element is correctly installed and connected to the appropriate terminals of the recorder — see **Electrical Connections,** page 6.
2. The voltage selector wire is set for the correct supply voltage and the mains supply is correctly connected — see **Electrical Connections,** page 6.
3. The linear motor operates freely.
4. The paper chart is correctly fitted and centralised on the take-up roller — see **Fitting a new Chart,** page 8.
5. The pen is writing cleanly and clearly — see **Fitting the Ink Reservoir,** page 9.
6. Measuring system is indicating correctly — see **Setting-Up, Zero and Span,** page 10.

On instruments with electric alarm/control systems:—

7. The plant is set for manual operation, i.e. is safe.
8. Relays are energised above or below set point as required. If not see **Changing the Control Action,** page 25.

On Motorised Valve Controllers:—

9. Motorised valve is operating correctly — see **Motorised Valve** Setting Up procedure, page 23.

Start-Up Procedure

Be sure that all the steps in the **Start-Up Check** have been completed.

1. Switch on mains supply to the recorder.
2. Switch on chart drive motor. If a two-speed or multispeed electronic chart drive system is fitted, select the desired speed — see **Chart Drive Systems,** page 17.
3. Adjust the set-point potentiometers to the required control values — see **Alarm/Control Point Setting,** page 14.

4. In the case of a proportional controller, if the optimum proportional band setting has been previously established, adjust to this value. If the optimum value is not known, set the proportional band to approximately 3% — see under appropriate control section pages 22 and 23.
5. Switch on mains supply to external alarm/control systems.
6. In the case of a proportional controller, adjust the proportional band setting for optimum control — see pages 22 and 23. The optimum setting for the proportional band will depend on the plant characteristics and is the minimum value which will give steady control. Too small a band will cause the controlled variable to oscillate as in ordinary two-step control and too large a band will give poor control with a slow return to the desired value after load changes.

PRINCIPLES OF OPERATION

Measuring System

The thermocouple or millivolt signal is amplified by a non-inverting MOS FET chopper stabilised feed-back amplifier. This configuration has a very high input impedance and the current passing through the signal source is 0.5nA maximum. By means of the span control the output signal is adjusted to 5 volts (nominal) for an input signal change equivalent to full scale deflection of the pen.

The pre-amplifier output signal is then compared with a reference voltage picked off the measuring slide-wire which is energised by a stabilised supply, and the difference amplified by the servo-amplifier whose output drives the linear motor. The motor carriage carries the indicating pointer, pen and the sliding contact on the slidewire. The motor itself consists of a coil assembly travelling in a magnetic field. The servo-amplifier drives the carriage in the appropriate direction to reduce the difference signal to zero.

An input filter circuit reduces any spurious signals picked up by the input leads and the base emitter junctions of two transistors are used for overload protection. Automatic cold junction compensation and broken sensor protection are provided if required.

If a resistance thermometer is used, it is connected to the recorder to form one arm of a resistance bridge, the millivolt output of which is fed into the pre-amplifier.

In multipoint versions of the recorder, a signal selector switch is driven by a synchronous motor. This unit is mounted on the lower right hand corner of the bulkhead behind the main frame. The pen changeover and dotting action is actuated by a second synchronous motor mounted on the main frame. The pen operation is electrically synchronised to the rotation of the signal selector switch and should they get out of step (e.g. due to maintenance work on the pen) the pen motor will stop at a predetermined point and only restart when the signal selector switch has rotated to its correct alignment. The linear motor is muted during signal changeover but dotting always takes place with the system "live".

The standard dotting interval is six seconds. Recorders with three second dotting can be supplied to special order provided the mains supply frequency is 50 Hz.

Averaging Pre-Amplifier

If the recorder is to be used to monitor a noisy signal, e.g. that from a flow transmitter, an averaging pre-amplifier can be fitted. This is a standard pre-amplifier with a filter circuit which lengthens the amplifier response time. The nominal time delay of 3, 10 or 30 seconds must be specified at the time the recorder is ordered.

Automatic Range Changing (two ranges)

Multipoint instruments fitted with automatic range changing have two pre-amplifiers with associated range cards in the positions shown in Figure 11, providing either of two ranges for each measured value channel. The range change switch is automatically operated by the rotation of the signal selector switch, is pre-set to the customer's requirements, and switches the appropriate pre-amplifier into the measuring circuit.
If automatic range changing is fitted the order of selection of the ranges set for the particular instrument is shown as a table on a label attached to pre-amplifier B in the recorder.

Isolator

An "Isolator Unit" may be fitted in the position marked "Pre-amplifier B" in Fig. 11. This isolator permits common mode voltages up to 500 volts 50 Hz to be present on the signal inputs. The servo-amplifier, linear motor and slidewire are earthed.

The isolator is operated from its own mains transformer which is fitted to the isolator printed circuit board. Isolation to 1000V peak is achieved by the use of an optical coupler between the input and output circuits of the isolator. The 0-5V D.C. output from the pre-amplifier is converted to a time-ratio signal, transmitted across the optical coupler and re-converted to a 0-5V analogue signal which is then fed to the servo-amplifier. The isolator board has its own zero and span adjustments. The potentiometers are mounted on the isolator printed circuit board below the transformer, zero on the left, span on the right. The board is set up at the factory during calibration and its zero and span potentiometers should not require any further adjustment.

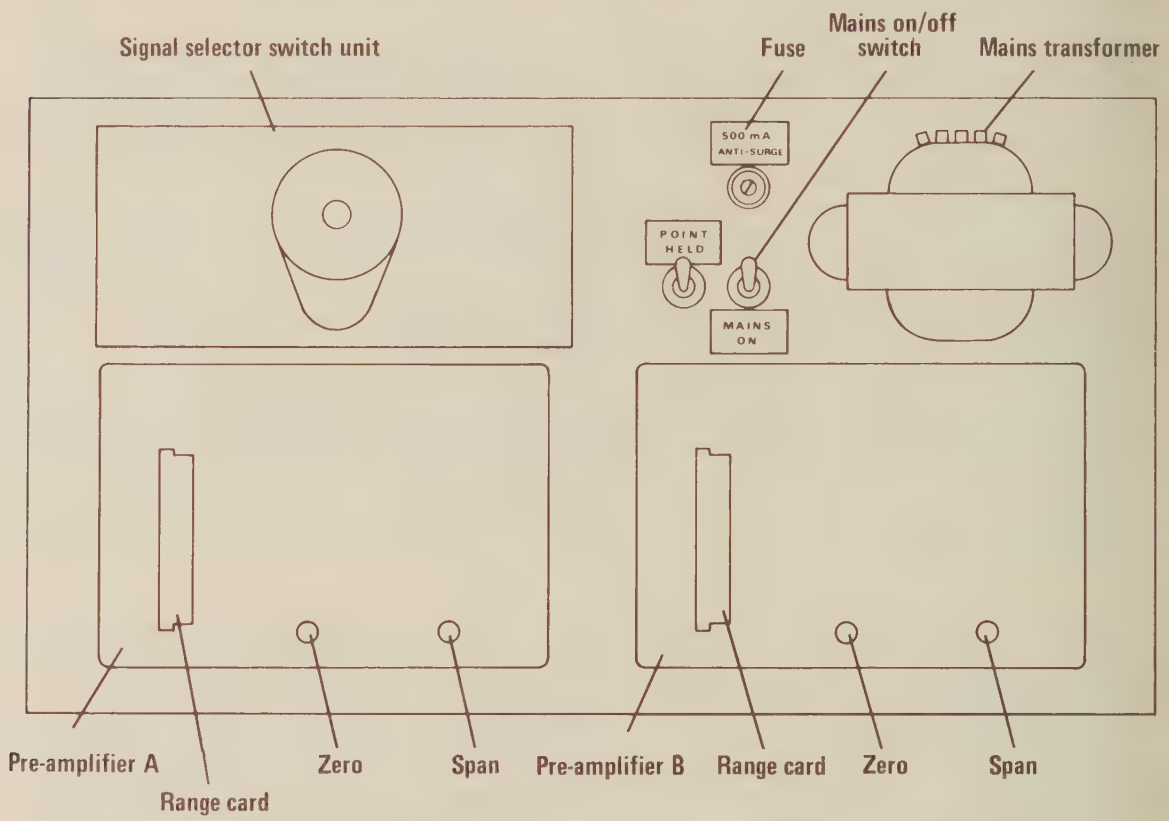


Fig. 11 Automatic Range Changing – Bulkhead Layout (Lower Section)

Conditioner

If the instrument is only to be used to record a transmitted signal of 0 to 10mA or 4 to 20mA, the pre-amplifier may be replaced by a conditioner. This circuit produces a 0 to 5V output which is compared with the reference voltage picked off the slidewire and the difference fed into the servo-amplifier as in the normal recorder.

The conditioner is fitted in the pre-amplifier housing and zero and span controls are accessible in the same positions as on a pre-amplifier.

Square Root Extractor

This circuit linearises a square law signal such as is obtained from a flow transmitter. If the recorder is to be used to monitor such a signal this circuit may be fitted in place of the pre-amplifier. The circuit accepts a signal of 0 to 10mA, 4 to 20mA or 0 to 5V and produces a 0 to 5V output which is compared with the reference voltage picked off the slidewire, the difference being fed into the servo-amplifier as in the normal recorder.

The square root extractor is fitted in the pre-amplifier housing and zero and span controls are accessible in the same positions as on a pre-amplifier.

If the signal is noisy, e.g. because of a rapidly changing flow rate, a filter circuit may be fitted to increase the response time.

Calorimeter Converter

If the recorder is to be used with a Foster Cambridge Thomas Gas Calorimeter the pre-amplifier is replaced by a Converter Unit. This is essentially an A.C. Wheatstone Bridge with the nickel calorimeter thermometers connected in adjacent arms. As the temperatures of the thermometers vary the bridge becomes unbalanced and this imbalance is amplified, converted to a D.C. signal and then amplified again. The converter output signal is then compared with a reference voltage picked off the slidewire and the difference fed into the servo-amplifier as in the normal recorder.

Chart Drive Systems

Four alternative systems are available. The simplest is the single speed drive where the drive from the chart drive motor is coupled directly to the vertical main drive shaft through the bevel gearing. With this system the chart drive speed can only be changed by replacing the motor.

The second chart drive system allows the user to select either of two chart speeds by operating a three position (High-Off-Low) switch on the chart unit front panel. The speeds required must be specified at the time the recorder is ordered as the speeds are determined by the motors fitted. The high speed is obtained with the switch in the up position and the low speed with the switch in the down position.

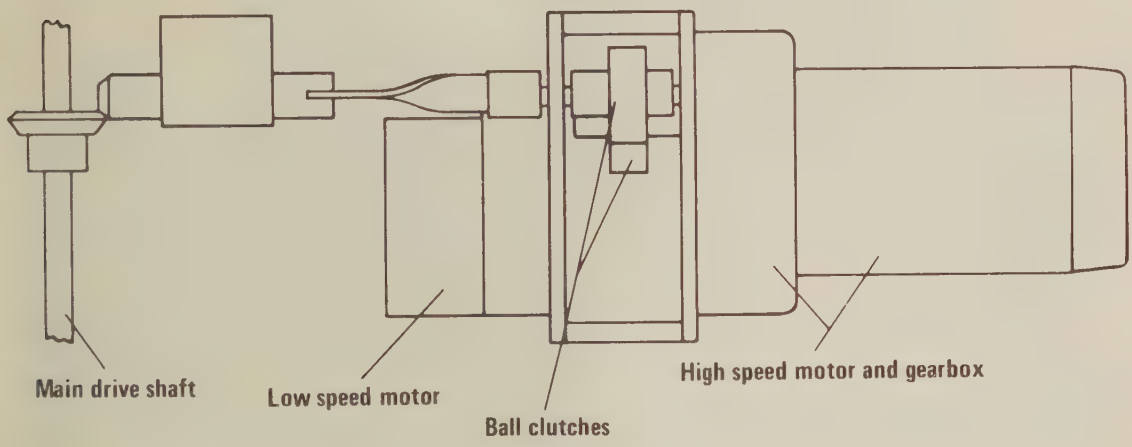


Fig. 12 Two Speed Chart Drive

The third system incorporates a simple gearbox between the chart drive motor and the vertical main drive shaft. By selecting appropriate pairs of worms and wheels for this gearbox, the chart drive speed can be quickly and easily changed without the use of spanners or other tools.

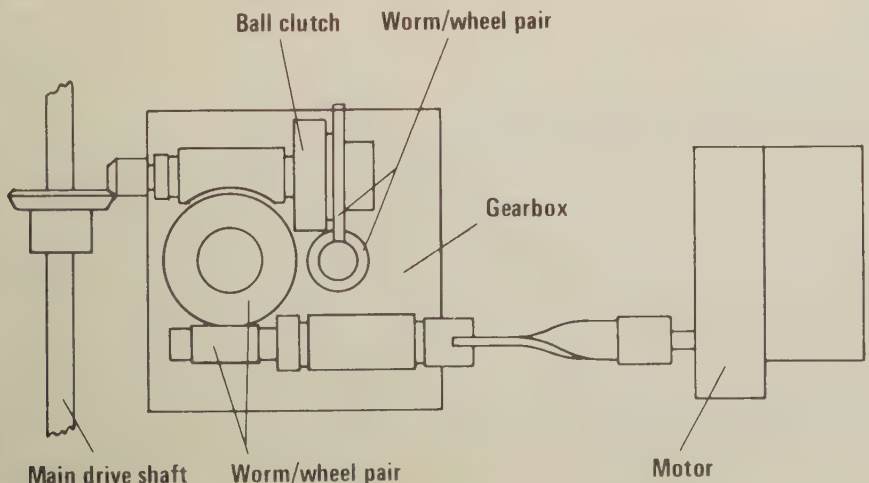


Fig. 13 Multispeed Chart Drive

The fourth chart drive system is an electronically operated stepper motor coupled directly to the vertical main drive shaft through bevel gearing. The speed can be changed by rotating a numbered thumb wheel switch above the chart drive switch to the left of the chart. The chart speeds corresponding to the numbers 1 to 6 on the wheel are printed on a label above it, and are normally 5, 10, 20, 30, 60 and 120mm/hour respectively.

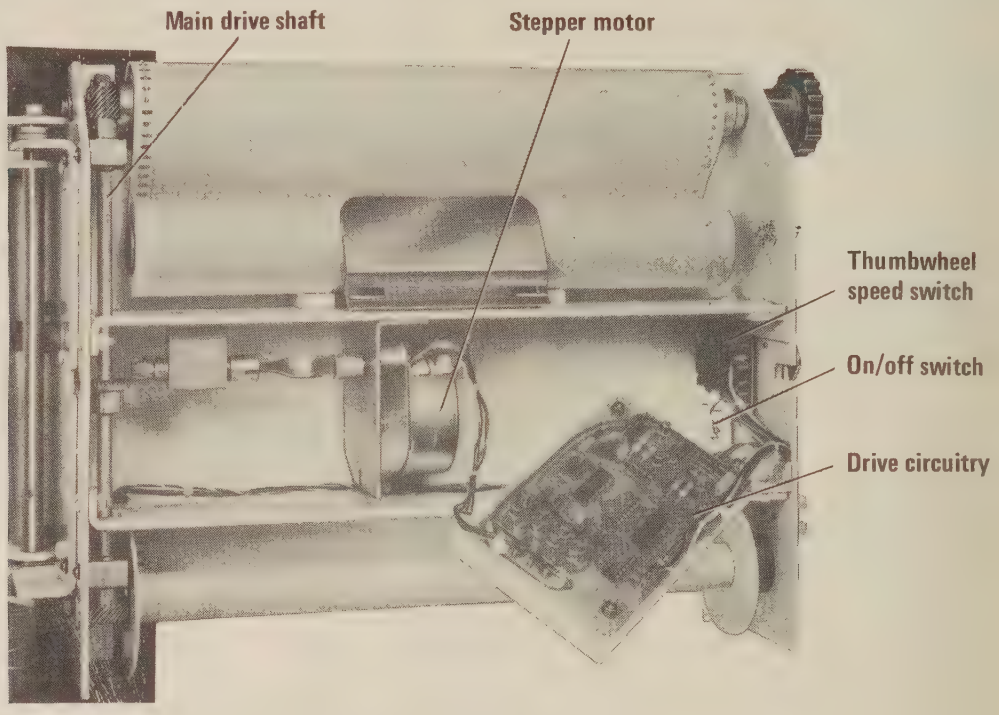


Fig. 14 Electronic Chart Drive

Autoswitch for Chart Motor

An autoswitch can be fitted so that the chart motor only operates when the measured value is above a certain preset value. This switch is operated by one of the control points, and is set in the same way – i.e. by the appropriate set point potentiometer adjustment.

Chart Illumination

A fluorescent lamp may be fitted on the inside of the door to illiminate the chart and scale. The starter and choke are mounted on the bulkhead adjacent to the mains switch and fuse (see Fig. 8).

Event Marker

An event marker is available as an optional extra, the pen writing a continuous trace on the right-hand side of the chart. The chart width available for measured value recording is reduced by about 5% and a stop is fitted to limit the upscale travel of the measured value pointer. The event marker pen is set to record on the same time lines as the measured value pen. The ink reservoir is fitted in a similar manner to that for the single point recorder.

Continuous Recording of One Point on a Multipoint Recorder

In this variant the multipoint pen unit has a special continuous writing pen added. When continuous monitoring of a particular point is required the signal selector and dotting motors are switched off by the Point Hold switch and the continuous writing pen rotated from the rest position to the vertical writing position.

The ink reservoir is fitted in a similar manner to that of the single point recorder. When fitting a new reservoir be careful not to pull the reservoir mounting bracket forward so that it interferes with the multipoint pen mechanism.

NOTE: If the continuous writing pen is in use, before unlatching the chart unit from the main frame, turn the pen through 90° anti-clockwise to the horizontal position by gently pressing and rotating the knurled wheel. **Do not** close the chart unit into the main frame with the continuous writing pen in the vertical position.

Individual set point potentiometers are fitted above the measured value scale (see Figs. 7 and 10) and connected, in parallel with the measuring slidewire, to a stabilised reference voltage.

The control unit is mounted on the upper part of the bulkhead – see Fig. 8. One of five different units is used depending upon the control requirements. Three of the units incorporate single printed circuit board assemblies with plug-in relays for standard applications. The fourth and fifth are more complex modular systems arranged so that they can be interconnected in different ways to provide many variations for particular specialised control requirements.

To gain access to the control unit open the instrument and swing back the main frame and chart unit. Switch off the mains supply. In the case of Control Units 4 and 5, remove the control unit cover plate by undoing the three retaining screws. This plate ensures that the printed circuit boards and relays are fully engaged in their sockets and prevents them moving during transit.

Control Unit 1, when fitted in single point recorders, has one or two control channels each of which may be on/off or provide a current output for a retransmission signal; one channel may have time proportional control. Multipoint recorders with Control Unit 1 are limited to on/off action common to all measuring points.

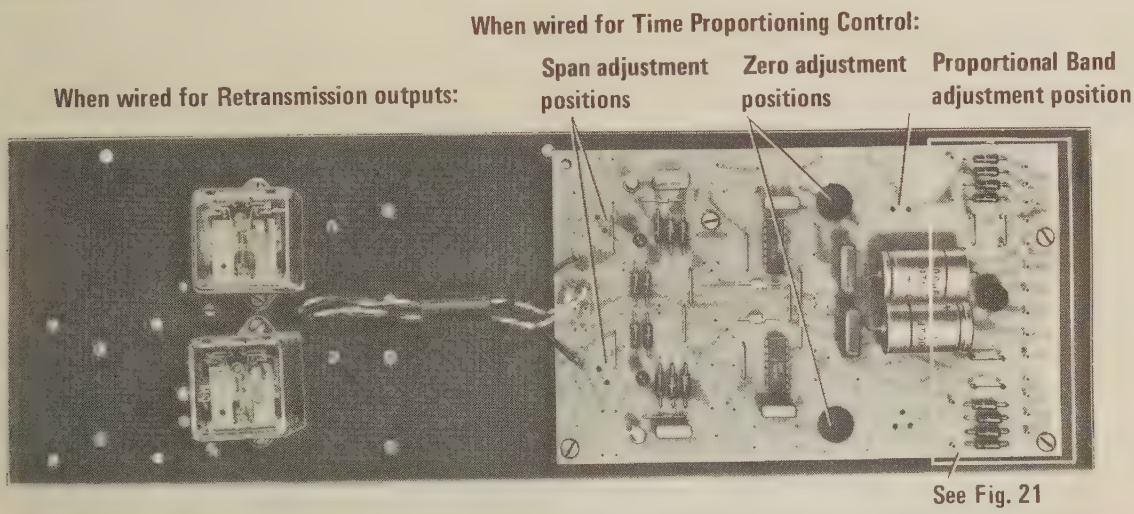

When wired for Time Proportioning Control:
When wired for Retransmission outputs:
Span adjustment positions
Zero adjustment positions
Proportional Band adjustment position
See Fig. 21

Fig. 15 Control Unit 1 – Wired for On/Off Control

Control Unit 2 is no longer available. The control parameters previously provided by that unit are incorporated in Control Unit 4 (Fig. 17).

Control Unit 3 provides up to six on/off control channels on multipoint recorders only, with not more than one channel for each measuring point.

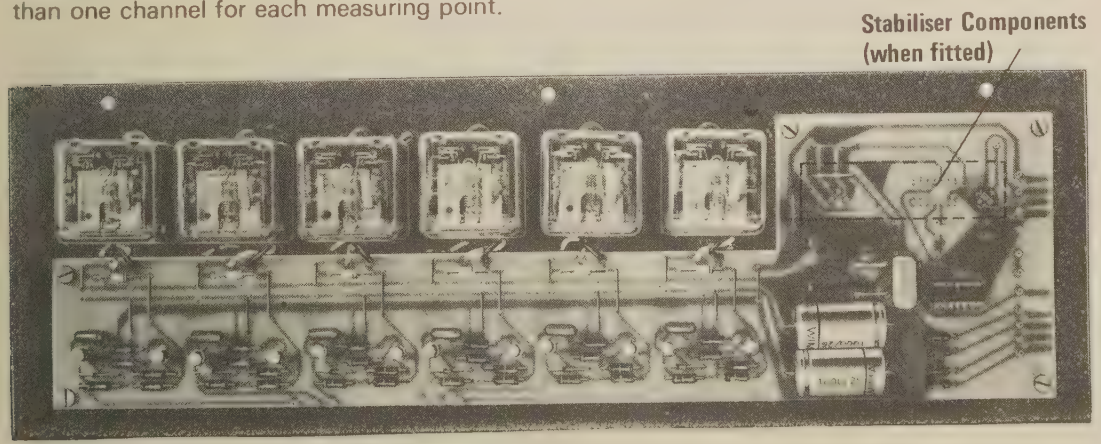
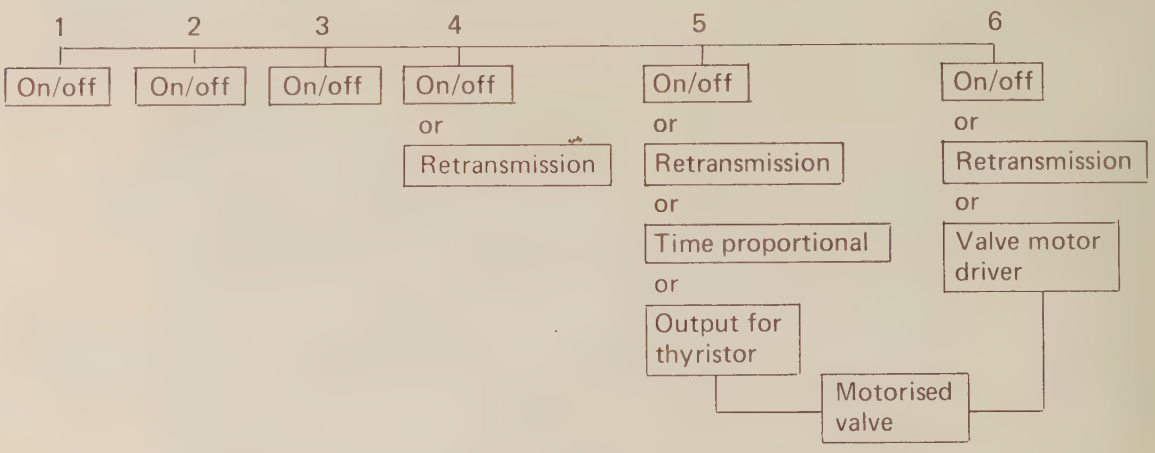


Fig. 16 Control Unit 3

Control Unit 4 is used in single point instruments only and provides up to six control channels. It comprises a base printed circuit board into which may be plugged 6 control circuit boards and a power supply board. The base printed circuit board is numbered 1 to 6 to identify the socket for each set point. The control functions possible for each set point are shown in the diagram:—



Each plug-in board is marked with a code number to show its control function. Table 3 below gives the derivation of the code number:

Type	Description
A1	On/off Single-Point E.A.
A2	On/off Single-Point E.B.
B1	Retransmission 0—10mA Buffer Drive
B2	Retransmission 4—20mA Buffer Drive
B3	Retransmission 0—10mA Slidewire Drive
B4	Retransmission 4—20mA Slidewire Drive
C	Motorised Valve
D1	P + I Thyristor Drive 0—10mA
D2	P + I Thyristor Drive 0—5mA
D3	P + I Thyristor Drive as used with Motorised Valve
D4	Proportional, Thyristor Drive 0—10mA
D5	Proportional, Thyristor Drive 0—5mA
D6	Proportional, Thyristor Drive as used with Motorised Valve
E1	P + I, Time Proportional
E2	Proportional, Time Proportional
P1	Power Supply all units except
P2	Power Supply, Motorised Valve &/or P + I Thyristor Drive

Table 3. Control Unit 4 — Plug-in Board Coding

If Control Unit 4 is fitted, the control function for each set point in the instrument is shown on a label attached to the cover over the control unit.

The on/off control printed circuit board can be wired for relay energised above or below set point, time proportioning control or retransmission signal, and will plug into any of the sockets 1 to 4. This board will also fit sockets 5 and 6 providing that these are not keyed for thyristor drive or motorised valve operation, but it will not fit into the power supply socket. The circuit boards for thyristor drive, motorised valve operation and power supply are keyed so that they will only fit into their correct positions.

A plug-in circuit board will not necessarily function correctly if plugged into another accepting socket unless the base printed circuit board has been wired for that control function at that socket. Users desiring to change the control function of any of the set points should contact Kent Industrial Measurements Ltd.

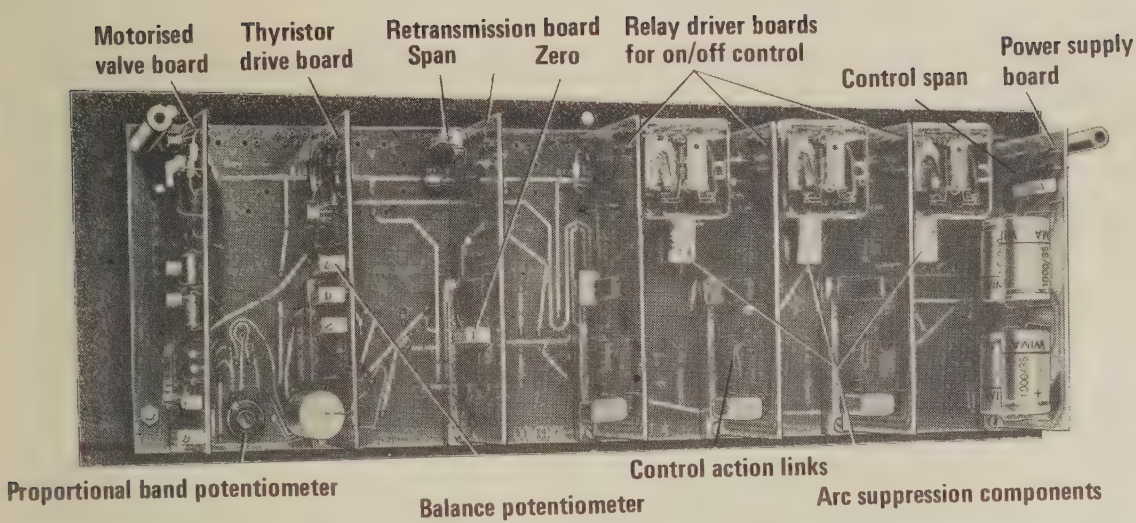


Fig. 17 Control Unit 4 – Typical Arrangement of Control Functions

Control Unit 5 provides on/off control for up to 6 set points which can be distributed in any combination across the measuring channels of a multipoint recorder, i.e. up to six set points can be associated with any measuring channel and any number of measuring channels can be associated with each set point. The control unit comprises a base printed circuit board into which are plugged six relay driver circuit boards, a matrix board and a power supply board (type P1). Each type of board is keyed so that it cannot be fitted into the wrong socket. The relay driver boards are wired for energising above set point (identified by A3 on label) or for energising below set point (identified by A4 on label) and are otherwise interchangeable. Numbers 1 to 6 on the base printed circuit board identify the set points, which are adjusted as described on page 14

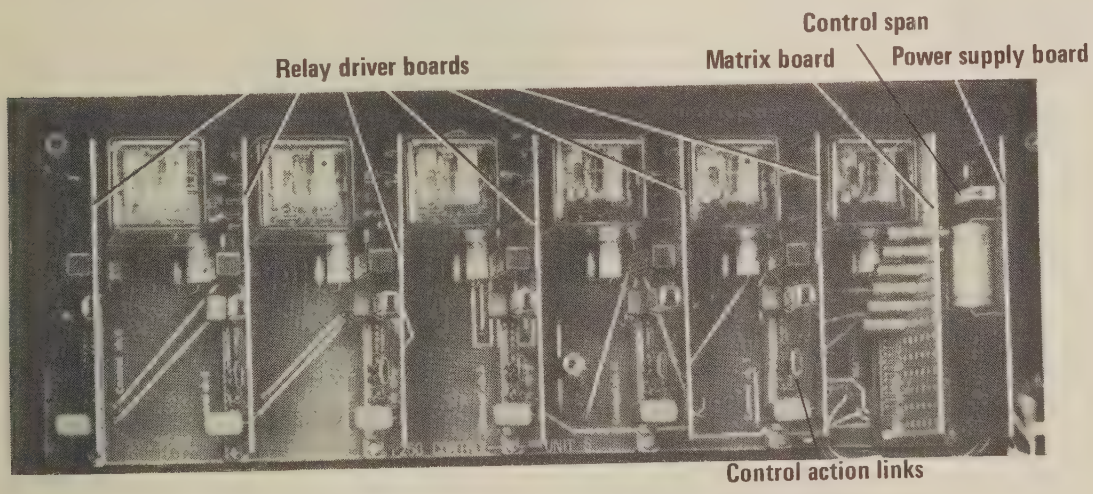


Fig. 18 Control Unit 5 – with Six Control Points

The distribution of the set points is determined by the position of diodes on the matrix board (see Fig. 22). For example, all six channels may be set to the same recording points; five channels to one point and one channel to any other; or any combination through to one control channel for each of six points. The programme is normally set to customer's requirements before the recorder is despatched. It may be changed by repositioning the diodes on the matrix board as described on page 26.

On/Off Control/Alarm

The signal from the pre-amplifier is compared with the relevant set point voltage and the difference signal fed to the control circuit. This consists of an amplifier with a small delay circuit, followed by a Schmitt trigger which operates a relay when the difference signal changes polarity, i.e. as the indicating pointer passes the set point.

Two sets of change-over contacts are available for external connection for each control/alarm point. These are labelled normally closed, common and normally open – normally being when no current is flowing in the relay coil. Alarm systems should have an independent power supply to safeguard alarm operation in the event of mains failure.

Time Proportioning, Proportional + Integral (P + I) Controller

Proportioning action is obtained within the proportional band by the continual switching on and off of the control relay, the time on to time off ratio varying according to the position of the indicating pointer within the proportional band. By adding an integral term the proportional band is automatically offset to compensate for load variations. The proportional band potentiometer is labelled and mounted on the control unit circuit board on the upper section of the bulkhead. Further set points may be fitted, with an on/off action for alarm purposes.

Arc Suppression Components

On Control Units 1, 2 and 3 these components are located under covers alongside the terminal blocks in the rear compartment of the instrument. On Control Units 4 and 5 they are immediately below the relays on the control unit printed circuit board (see Figs. 17 and 18).

A 0.01 microfarad capacitor is connected across each set of N/C contacts. These contacts are normally used for switching alarm circuits. In order to reduce contact burning when switching highly inductive loads a 0.047 microfarad capacitor is connected across the N/O contacts. If an intermediate relay is used in this switching circuit, capacity current through the 0.047 microfarad capacitor may cause the intermediate relay to hold in.

On early instruments both sets of N/O contacts on each relay are fitted with 0.047 microfarad capacitors. On later instruments one set of N/O contacts of each relay has a 0.01 microfarad capacitor fitted; the contacts with 0.047 microfarad suppression are then marked N/0.1 on the terminal label. The N/0.1 contacts should be used to switch heavy duty contactors and the N/0 contacts to switch light duty intermediate relays.

Retransmission Signal

To generate a retransmission signal, the on/off controller circuit is modified to act as an amplifier producing an output current proportional to the position of the indicating pointer on the scale.

The 0–10mA or 4–20mA current outputs can be used for the operation of one or more remote indicators or controllers. The limit to the number of remote instruments is governed by the total external resistances (i.e. cable resistance plus sum of remote instrument resistances) which must not exceed 1,000 ohms or 500 ohms respectively. The remote instruments must be connected in series. A short circuit will not damage the P250L recorder but the output current must not be earthed if the sensor signal (from the thermocouple, resistance thermometer, etc.), is earthed.

If the remote instrument is voltage operated, a high stability resistor should be connected across the input terminals of the remote instrument to convert the current signal to a voltage – e.g. a 500 ohm resistor will develop 0–5V, with a 0–10mA current. The resistor may be fitted in the P250L recorder if the voltage output is specified when the instrument is ordered.

The retransmission signal zero and span setting controls are labelled on the control unit printed circuit board. Their positions on a Control Unit 4 Retransmission board are shown in Fig. 17, and on a Control Unit 1 board in Fig. 15.

The output connections are labelled O/P, 0–10mA (or 4–20mA) +ve and –ve, or O/P Volts +ve and –ve.

P or P + I Controller for Thyristor Drive

An amplifier in the P or P + I controller generates an output current of 0–5mA or 0–10mA suitable for controlling a thyristor trigger circuit. The magnitude of this current changes as the indicating pointer traverses the proportional band. The output current is normally at maximum when the indicating pointer (recording pen) is below the set point and outside the proportional band. The current decreases linearly within the band so that zero output is obtained when the indicating pointer is at the upper limit of the band. Reversed action may be supplied if required. By adding an integral term the proportional band is automatically offset to compensate for load variations.

The proportional band potentiometer is labelled and mounted on the control unit circuit board on the upper section of the main bulkhead. The output connections are labelled O/P, 0–5mA or 0–10 mA, + and – on the rear terminal block. Further set points can be fitted with a two-step action for alarm purposes.

P or P + I Motorised Valve Controller

This controller operates a valve positioning motor of the Billman or similar type. An external motor power supply must be provided. Solid state switches inside the controller are used to complete the 'open' and 'close' motor circuits. Valve position feedback information from the slidewire on the positioning motor is continuously compared with the output current from the thyristor drive controller amplifier. Any disparity operates a Schmitt trigger circuit to complete the 'open' and 'close' motor circuit for the valve. By adding an integral term the proportional band is automatically offset to compensate for load variations. The valve traverse time must be small compared with the integral action time.

A proportional band control and a balance potentiometer are fitted on the control unit printed circuit boards and labelled — see Fig. 17.

Further set points may be fitted with two-step action for alarm purposes.

The secondary of the motor supply transformer, the motor open and close windings and the motor position feedback slidewire should be connected as shown in Fig. 19 (and on the terminal block label). Fig. 19 shows the connections for valve open below set point. For valve open above set point, reverse the connections to the valve motor (Billman terminals 2 and 3) and slidewire (Billman terminals 4 and 5).

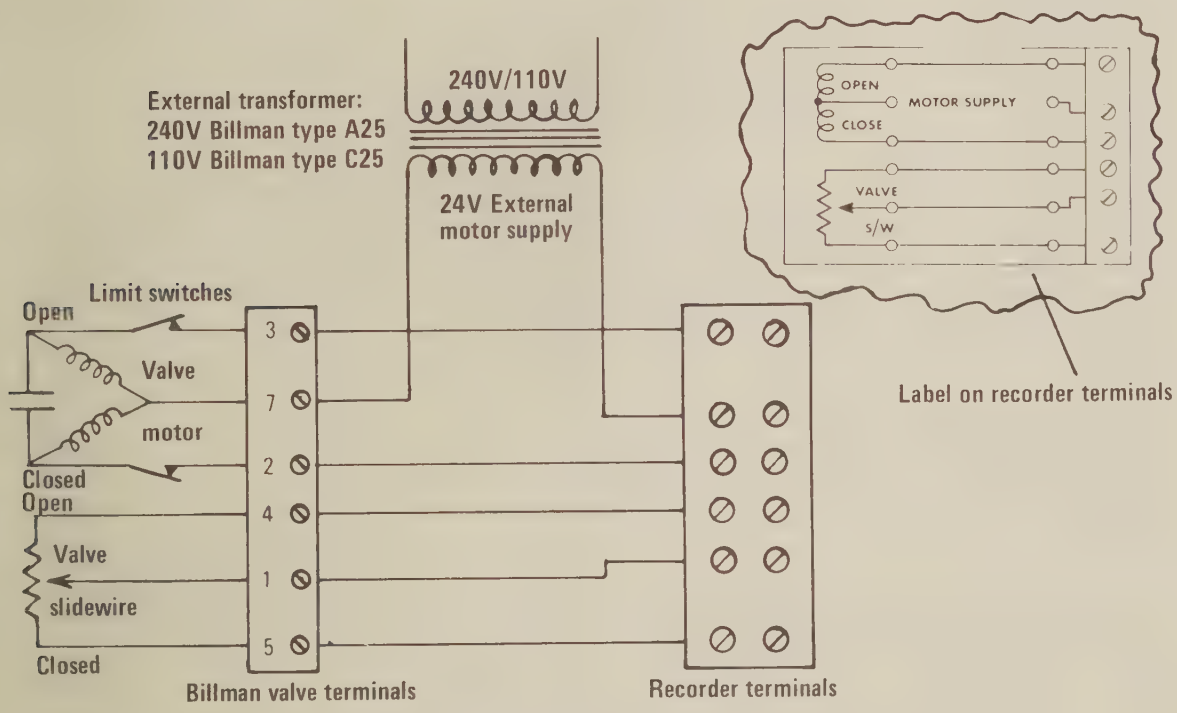


Fig. 19 Billman Valve Type ME6V — Wiring Diagram

Setting Up

If the slidewire meets the specification on page 3, then a position can be reached such that the valve is fully closed at one extreme of the proportional band and fully open at the other extreme.

Drive the recorder upscale, below the proportional band — valve closed. Check that the valve is fully closed. If not, adjust the balance potentiometer by means of a screwdriver until the valve is just closed.

Drive the recorder downscale, below the proportional band — valve open. Check that the valve is fully open. If not, adjust the balance potentiometer again. Re-check the closed position of the valve.

CHANGES TO INSTRUMENT OPERATION

Changing the Chart Speed (Worm and Wheel System)

Unscrew the knurled retainers and remove the worm and wheel pair which is to be replaced. Fit the new gear wheel first, checking that the pin enters the hole in the wheel, then fit the worm. The slot on the worm fits over the rib on the boss of the driving shaft. Replace the retainers.

When changing speeds it is immaterial which set of gears is changed provided that they are kept as pairs.

Table 4 summarises the chart speeds available and the reference numbers of the gear sets required. For chart speeds above 120 mm/hour a special high powered motor is required.

GEAR SET (part Nos. in brackets)	WB1A (P250/65/2254) GB1A (P250/65/2253)	WA1 (B1507A) GB1 (B1513B)	WA2 (B1508A) GB2 (B959B)	WA3 (B1509A) GB3 (B960B)	WA6 (B1512A) GB6 (B1514B)	SPEED	MOTOR
WA1 (B1507A) GB1 (B1513B)	5	10	20	30	60	mm/h	Standard
WA2 (B1508A) GB2 (B959B)	10	20	–	60	120	mm/h	Standard
WA1B(B963B) GB1B (180/208)	300	600	1200	1800	3600	mm/h	High power

Table 4. Multispeed Chart Drive (Worm = W, Gear = G)

Broken Sensor Protection

Upscale drive may be changed to downscale drive or vice versa by moving a link on the pre-amplifier. First, turn off the mains switch. Remove the pre-amplifier from its housing by undoing the four retaining screws in the cover from which the range card protrudes. The position of the link for each action is shown in Fig. 20. Not more than one link should be present. If no drive is required under open-circuit input conditions no links should be present.

If the recorder was not previously wired for either upscale or downscale drive a resistor R8 must also be added to the range card. The value of this resistor depends on the recorder span, as shown in Table 5.

Recorder span	R8
1 to 5mV	5MΩ
5 to 10mV	2MΩ
10 to 50mV	680kΩ
50 to 100mV	180kΩ

Table 5. Values of R8 for Upscale/Downscale Drive

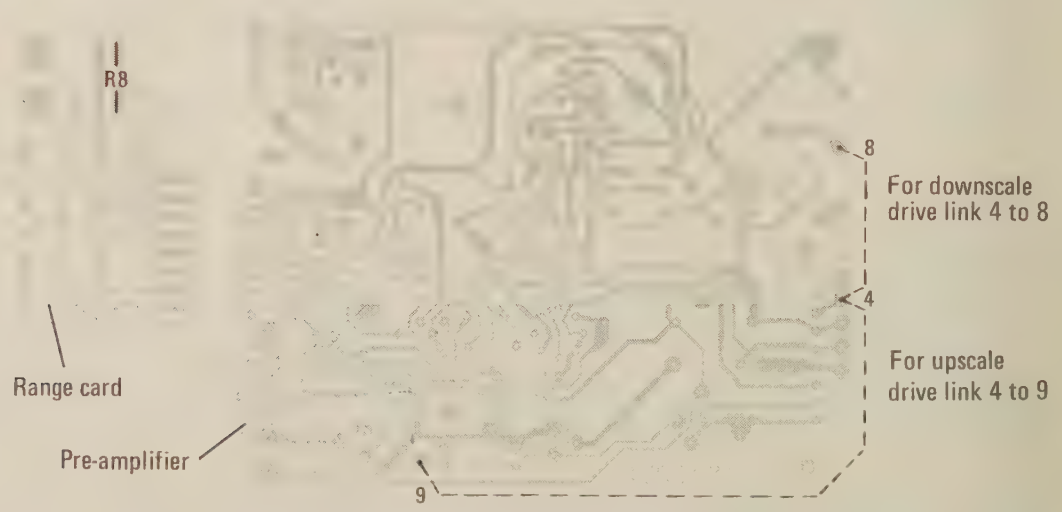


Fig. 20 Upscale/Downscale Drive Links

Changing the Control Action

Control Unit 1

To invert the mode of relay operation, i.e. to change from energising above (EA) to energising below (EB) set point, or vice versa, refer to the control unit printed circuit board and identify the turret tags outlined in Fig. 15 and shown in Fig. 21. Each group of four turret tags applies to one relay. If the links between the tags are horizontal the relay is energised below set point and if the links are vertical the relay is energised above set point.

If one of the set points is fitted with time proportioning action, the circuit board is wired differently and no attempt should be made to change the control action on this set point. The action of the other set point can be changed as described above.

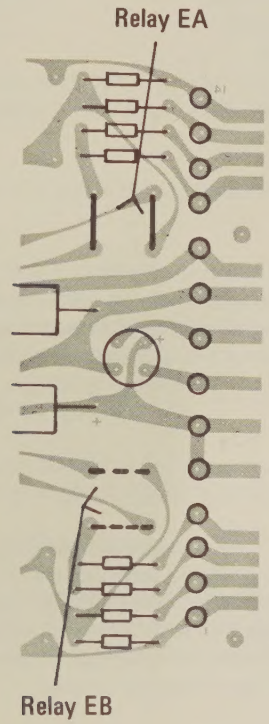


Fig. 21 Control Unit 1
– Changing the Control Action

Control Unit 3

The relay driver board for Control Unit 3 is wired to the customer's requirements for EA or EB on each of six channels. If a change of relay action is required, contact the nearest Foster Cambridge Service Centre.

Control Unit 4

The relay driver boards are wired for energising above set point (identified by A1 on label) or energising below set point (identified by A2 on label). To change the control action remove the cover plate, unplug the relay driver board and replace it with one of the opposite action. If an alternative board is not available the control action may be reversed by moving the two links shown in Fig. 17 along one hole, i.e. from to or vice versa. Replace the control unit cover plate.

Control Unit 5

The relay driver boards are wired for energising above set point (identified by A3 on label) or energising below set point (identified by A4 on label). To change the control action remove the cover plate, unplug the relay driver board and replace it with one of the opposite action. If an alternative board is not available the control action may be reversed by moving the two links shown in Fig. 18 along one hole, i.e. from to or vice versa. Replace the control unit cover plate.

Changing the Distribution of Set Points for Control Unit 5

The distribution of set points for Control Unit 5 may be changed by altering the position of diodes on the matrix board as shown in Fig. 22. The diodes are held in position by nuts on the back of the matrix board.

Fig. 22 shows a matrix board set for high/low control on recording points 3 and 8, and on/off control on points 4 and 5. Introducing the extra diode at control channel 2, point 9 gives common on/off control exclusive to points 5 and 9.

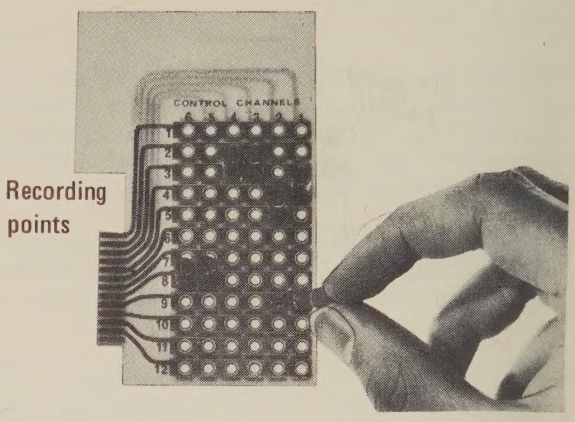


Fig. 22 Control Unit 5 — Matrix Board

Changing Range

The range card plugs into a vertical slot in the pre-amplifier. Each range card is labelled with its range. To change the range, swing back the main frame out of the instrument. Press the spring clip on the range card away from the edge of the slot in the pre-amplifier housing and withdraw the range card. Depress the clip on the new range card and insert it in the slot with the component side to the right so that the clip engages on the inside edge of the slot. After changing range, re-check the zero and span settings as detailed on page 10.

MAINTENANCE

Lubrication

Every six months, lubricate the bearings and sliding parts of the chart drive mechanism, the multi-point pen mechanism and the signal selector mechanism (but **not** the switch wafers) using a good quality oil, such as Moebius 8040/35 clock oil (supplied by Henri Picard & Frère). On no account may any of this lubricant be used on the slidewire. To lubricate the bearings in the signal selector switch, it is necessary to remove the L-shaped cover by undoing the retaining screws.

Do not lubricate the linear motor carriage bearings.

Lubricate the main frame/chart unit hinge with a medium/heavy grade machine oil.

Linear Motor Adjustment

If the linear motor carriage does not move freely along the field forming rod, adjustment of the rail skid (Fig. 4) may be necessary to compensate for possible wear and/or to centralise the motor coil assembly about the field forming rod. Slacken the skid retaining screw (Fig. 4), rotate the skid approximately ⅓ of a turn and tighten the screw in its vertical slot, ensuring that the motor coil assembly is positioned concentrically about the rod.

Cleaning the Scale

Dirt or grease marks on the scale can be removed by lightly rubbing with a cloth pad soaked with Genklene (made by I.C.I.).

Cleaning the Slidewire (see Fig. 7)

Take off the top cover by slackening the four retaining screws.

Oscillation of the pen at certain points on the scale is symptomatic of a dirty slidewire or slidewire wiper. Clean the slidewire by washing it thoroughly with Genklene using a camel-hair brush, paying particular attention to the area between the slidewire turns.

Cleaning the Multipoint Pen Mechanism

Use a camel-hair brush and Genklene (made by I.C.I.) to clean the moving parts of the pen mechanism. After cleaning, re-lubricate with Shell Microtime 'H' molybdenised clock oil.

Cleaning the Signal Switches

The contacts of the rotary channel selector switch are self-lubricating. Remove debris with a soft nylon brush. Do not use any abrasive compound on the contacts. Wipe with a lint-free cloth or chamois leather only.

Changing a Control Relay

Switch off the mains supply. In the case of Control Units 4 and 5, remove the control unit cover plate by undoing the three retaining screws. Unplug the faulty relay and replace it with a new relay, pressing it firmly into place.

Replace the control unit cover plate and tighten the screws. Switch on the mains supply.

Changing the Fluorescent Lamp

Switch off the mains supply. Rotate the faulty lamp through 90° so that the pins on the end of the lamp will pass through the slots in the mounting brackets and lift it out. Locate the pins on the end of the new lamp in the slots in the mounting brackets and rotate the lamp through 90°. Switch on the mains supply.

Changing the Fluorescent Lamp Starter (see Fig. 8)

Switch off the mains supply. Rotate the starter anti-clockwise and pull it out. Insert the replacement starter and rotate it clockwise to hold it in place. Switch on the mains supply.

Identification of Synchronising and Muting Microswitches

The position of the synchronising and muting microswitches is shown in Fig. 23, and their part numbers are given in the **SPARES LIST.** A full description of the replacement of faulty microswitches and information on alignment procedures is given in the P250L Service Manual available from Kent Industrial Measurements Ltd.

"Moulded" Multipoint Pen Mechanism

Multipoint recorders are now supplied fitted with a moulded pen mechanism as an alternative to that fabricated from castings. The profile of the cam which operates the dotting bar is different for the two types of print mechanism and if the type of pen mechanism is changed the dotting cam must also be changed. Full instructions on replacement and alignment procedures are given in the P250L Service Manual available from Kent Industrial Measurements Ltd.

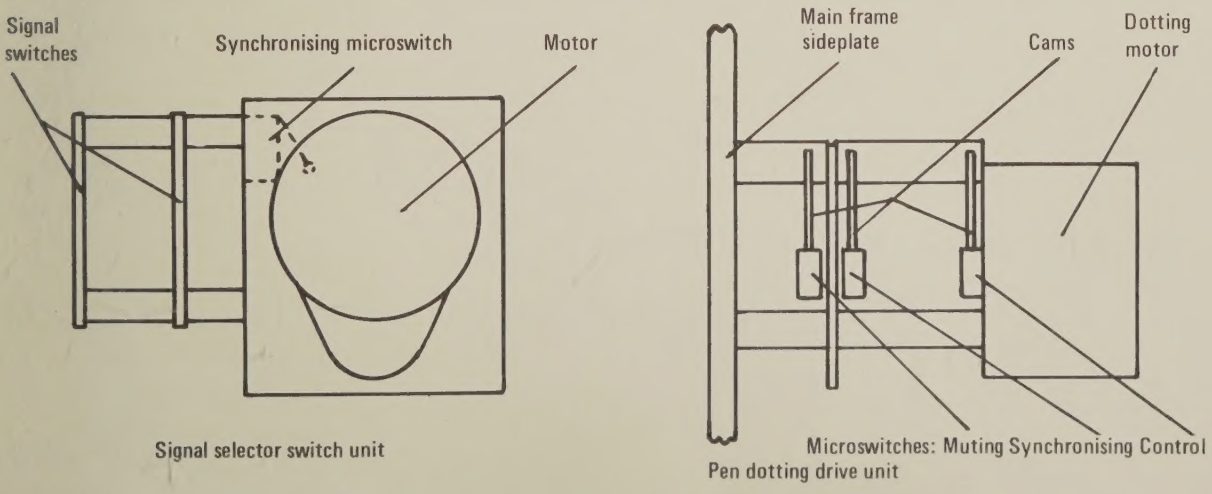


Fig. 23 Microswitch Identification

MP MASTER
MA23420

SPARES LIST

Description	Part Number	Reference
Bench stand	P250/50/3547	
Chart	Quote reference number on chart supplied	
Chart drive motor	Specify type number and speed of rotation marked on motor	Fig. 12 or 13
Chart illumination: Fluorescent tube	B1544 (Thorn type MGF/u; 12in, 8W)	
Choke 110V	B5571 (Thorn type AME 62816)	Fig. 8
Starter 110V	B5572 (Thorn type 155/100)	Fig. 8
Control microswitch	B5430	
Control relay	B4961	
Control Unit 1 or 3 printed circuit board assemblies	Specify exact control functions required and recorder serial number	Figs. 15 & 16 respectively
Control Unit 4, base printed circuit board	Specify exact control functions required and recorder serial number	Fig. 17
Control Unit 4, plug-in printed circit board assemblies	Specify type reference	Fig. 17
Control Unit 5, base printed circuit board	Specify numbers of relays and recorder serial number	Fig. 18
Control Unit 5, plug-in printed circuit board assemblies:		Fig. 18
Power supply	Power supply, P1	Fig. 18
Matrix board	P250/93/10017	Figs. 18 & 22
Matrix board diode	P250/93/10077	Fig. 22
Relay board (EA)	Relay board, A3	Fig. 18
Relay board (EB)	Relay board, A4	Fig. 18
Door lock and key	B3030	
Fuse 500 mA	B4249 (B6486 for 20mm long fuses)	Figs. 8 & 11
Mains transformer	P250/66/2412	Figs. 8 & 11
Multipoint pen inks	Black—B1521 Green—B1524 Blue—B1522 Red—B1525 Violet—B1523 Orange—B1526	
Multipoint signal selector and pen dotting motor	Specify voltage, speed and direction of motor marked on faulty motor	
Muting microswitch	B5430	Fig. 23
Potentiometer for screwdriver adjusted set point	B5603	Figs. 7 & 10
Pre-amplifier printed circuit board assembly	P250/70/2709	Figs. 8 & 20
Pushbutton switch unit	P250/79/3171	Fig. 10
Range card	Specify range and signal sensor	Figs. 8, 11 & 20
Scale	Specify range and signal sensor	Fig. 10
Service manual	P250/50/3549	
Servo-amplifier printed circuit board assembly	P250/69/2616	
Single point pen fibre tip nibs	B4923 (pack of 4)	
Single point pen ink capsule	B4572	
Synchronising microswitches: Moulded pen	B6296	
Dotting motor	B5430	
Signal selector switch	B5430	Fig. 23
Worm and wheel chart drive gears	Specify from Table 4 on page 24	Fig. 13
Made up kits: Chart tear off bar and fittings	P250/50/3622	
Multipoint spares kit	P250/50/3606	
Single point spares kit	P250/50/3605	
Wall mounting bracket	P250/50/3548	Fig. 2

For information on other Spare Parts or Kits contact your local service centre.

SERVICE CENTRES

London Service Centre
Chaseside Works,
Chelmsford Road,
Southgate,
London N14 4JW
01-882 3737/8

Bristol Service Centre
119A Two Mile Hill Road,
Kingswood,
Bristol BS15 1BY
0272 679151/2

Birmingham Service Centre
Unit 14a,
Lee Bank House,
63 Blucher Street,
Birmingham B1 1HR
021-643 4114 or 021-643 6783

Glasgow Service Centre
52 Waddell Street,
Glasgow, C.5
041-429 3371

Manchester Service Centre
Lord Street,
Manchester M3 1HL
061-832 5391/2

Newcastle Service Centre
10 Hannington Street,
Newcastle-upon-Tyne NE6 1JT
0632 656126